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Universal joint tool adapter assembly

Abstract

A tool adapter assembly, such as, for example, a socket or socket adapter, having drive, center, and work bodies. The drive body and the work body can be adjusted in a number of positions/angles relative to one another by a user. The tool adapter assembly includes components adapted to retain a set/desired position/angle of the drive body and the work body relative to one another.

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Background/Summary

TECHNICAL FIELD

(1) The present invention relates generally to tool adapters, such as adapters for socket adapters and sockets, and more particularly to adapters with universal joints.

BACKGROUND

(2) Jointed tool adapters, such as, for example, socket adapters and sockets that utilize a universal joint, are used to engage and apply torque to work pieces, such as bolts, nuts, screws, etc. located in hard to reach places. These tool adapters allow transfer of torque from a torque application tool, such as, for example, a ratchet wrench, to a work piece at an angle with respect to a central axis of the work piece.

(3) Jointed tool adapters can be different sizes or shapes to account for different sized or shaped work pieces. For example, a bolt having a hexagonal head that is ½″ wide can be torqued with a ½″ socket. Such a socket would typically include a ¼″, ⅜″, or ½″ square female receptacle that would be matingly coupled with the torque application tool having a similar ¼″, ⅜″ or ½″ square male drive lug. To access work pieces in hard to reach or angled places, a user typically maneuvers the jointed tool adapter to engage the work piece. However, conventional tool adapters that utilize universal joints have difficulty in maintaining a pre-set position/angle desired by the user. For example, conventional tool adapters easily move from a position/angle set by the user, thereby increasing the difficulty for the user to successfully maneuver the tool adapter to engage the work piece. In another example, spring-loaded tool adapters, which utilize torsion springs around the pivots to maintain the universal joint in a straight line at rest, are difficult to engage a work piece that is at an angle to the torque application tool.

SUMMARY

(4) The present invention relates broadly to a tool adapter assembly. The tool adapter assembly includes a universal joint and tension and/or compression components to cause linear tension through the assembly, or cause compression forces against various components. This allows a position/angle to be set by the user, and the tool adapter assembly to retain the position/angle. In addition, the tension and/or compression components can be replaced, such that a stiffness of the assembly can be adjusted according to the user's preference or due to wear of the components.

(5) In an embodiment, the present invention broadly comprises a tool adapter assembly. The assembly includes a center body, a drive body rotatably coupled to the center body and is adapted to engage a lug of a torque application tool, and a work body rotatably coupled to the center body and adapted to engage a work piece. A stiffening member is disposed within the center, drive, and work bodies and is adapted to resist movement of the drive body and the work body relative to one another from a set position, or retain the set position of the center, drive, and work bodies relative to one another.

(6) In another embodiment, the present invention comprises a tool adapter assembly. The assembly includes a center body, a drive body, and a work body. The drive body rotatably is coupled to the center body and is adapted to engage a lug of torque application tool. The work body is rotatably coupled to the center body and is adapted to engage a work piece. The center body includes first and second apertures (such as for example, slots). An axial bore is disposed between the first and second apertures. The center body is rotatably coupled to the drive body with a first fastener (such as, for example, a pin). The center body is rotatably coupled to the work body with a second

fastener (such as, for example, a pin). The first and second fasteners in the center body are forced against the center body with a biasing member, such as, for example, a spring, disposed in the axial bore. This provides rotational resistance between the center body and drive body, and center body and work body.

(7) In another embodiment, the present invention broadly comprises a tool adapter assembly. The assembly including a center body including first and second apertures, and first and second rings respectively disposed in the first and second apertures. The rings may be made from a rubber or a similar material, although the invention is not limited as such. A drive body is rotatably coupled to the center body and is adapted to engage a lug of a torque application tool. A work body is rotatably coupled to the center body and is adapted to engage a work piece. The first and second rings to compress in an axial direction and/or expand in a radial direction when assembled due to a tight fit between the center and drive bodies and between the center and work bodies, or from a clamping force applied by threaded fasteners, although the invention is not limited as such. These rings allow the tool adapter assembly to resist movement of the drive body and the work body relative to one another from a set position, or retain the set position of the center, drive, and work bodies relative to one another.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) For the purpose of facilitating an understanding of the subject matter sought to be protected, there are illustrated in the accompanying drawings embodiments thereof, from an inspection of which, when considered in connection with the following description, the subject matter sought to be protected, its construction and operation, and many of its advantages should be readily understood and appreciated.

(2) FIG. **1** is a perspective side view of a tool adapter assembly, according to an embodiment of the present invention.

(3) FIG. **2** is a sectional view of the tool adapter assembly of FIG. **1** taken along line **2**-**2** of FIG. **1**.

(4) FIG. **3** is a perspective, disassembled view of a drive body, center body, and work body of the tool adapter assembly of FIG. **1**.

(5) FIG. **4** is a perspective, disassembled view of a tool adapter assembly, according to another embodiment of the present invention.

(6) FIG. **5** is a perspective view of a body portion of the tool adapter assembly of FIG. **4**.

(7) FIG. **6** is a perspective, disassembled view of a tool adapter assembly, according to another embodiment of the present invention.

(8) FIG. **7** is a perspective, disassembled view of a tool adapter assembly, according to another embodiment of the present invention.

(9) FIG. **8** is a side, assembled view of the tool adapter assembly of FIG. **7**.

DETAILED DESCRIPTION

(10) While this invention is susceptible of embodiments in many different forms, there is shown in the drawings, and will herein be described in detail, a preferred embodiment of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to embodiments illustrated. As used herein, the term “present invention” is not intended to limit the scope of the claimed invention and is instead a term used to discuss exemplary embodiments of the invention for explanatory purposes only.

(11) The present invention broadly comprises a tool adapter assembly, such as a socket or socket adapter, which has a universal joint with an improved ability to maintain a desired swiveled/pivoted position/angle. This is accomplished by using a stiffening mechanism disposed within the

assembly, applying a compressive force (such as, for example, a spring or springs) and/or friction force (such as, for example, rubber) to pins of the assembly together, or applying a compressive force (such, for example, as a spring or springs) and/or friction force (such as, for example, rubber) between a work body and center body and between a drive body and center body. The tension and/or compression components may be permanent, swappable, adjustable, and/or otherwise replaceable (such as in the event of wear).

(12) Referring to FIGS. **1-3**, a tool adapter assembly **100**, such as, for example, a socket or socket adapter, having a drive body **102**, a center body **104**, and a work body **106** is shown. The drive body **102** is rotatably or pivotably coupled to the center body **104** and the work body is rotatably or pivotably coupled to the center body, using fasteners (not shown for clarity), such as, for example, screws, rivets, welded pins, etc. Accordingly, the drive body **102** and the work body **106** can be adjusted in a number of positions/angles relative to one another by a user.

(13) The drive body **102** includes a female aperture **108**, for example, a square shaped bore, that is adapted to be releasably mated with a square male lug of a torque application tool, for example a ratchet or torque application wrench or breaker bar. The female aperture **108** can further include an indent **110** disposed on one or more inner surfaces thereof that is adapted to engage an outwardly biased ball disposed on the male lug of the tool. However, the invention is not limited as such and other means of releasably mating the drive body **102** to the lug of the tool can be used, such as, for example, a snap-ring, friction fit, etc. can be used. The drive body **102** further includes one or more drive body apertures **112** adapted to receive a fastener to rotatably couple the drive body **102** to the center body **104**. The drive body also further includes a drive body axial bore **114** adapted to receive a stiffening member **116**, which is described in more detail below.

(14) The center body **104** includes first **118** and second **120** center body apertures adapted to receive the fasteners and a center body axial bore **122** adapted to receive the stiffening member **116**. In an embodiment, the first **118** and second **120** center body apertures may be offset or angularly disposed by about 90 degrees with respect to each other. The drive body apertures **112** of the drive body **102** are aligned with opposing ends of the first aperture **118**, and a fastener is disposed in the drive body apertures **112** and first aperture **118** to couple the drive body **102** and the center body **104** together. This allows the drive body **102** to rotate or pivot about or around a first axis extending through the drive body apertures **112** and first aperture **118**.

(15) The work body **106** is adapted to engage a working piece, for example, a socket or fastener. In an embodiment, the tool assembly **100** is a socket adapter. Accordingly, the work body **106** includes a work body lug **124** and an outwardly biased ball **126** disposed on the work body lug **124** to releasably mate with, for example, a socket. However, the invention is not limited as such and other means of releasably mating to the work piece, such as, for example, a friction ring, can be used. In this example, the work body lug **124** is square, although the invention is not limited as such. In another embodiment (not shown), the tool assembly **100** is a socket. In this embodiment, the work body **106** includes a female aperture adapted to engage a head of a fastener, for example a bolt.

(16) The work body **106** includes one or more work body apertures **128** adapted to receive the fastener to rotatably couple the work body **106** to the center body **104**. For example, the work body apertures **128** are aligned with opposing ends of the second aperture **120**, and a fastener is disposed in the work body apertures **128** and second aperture **120** to couple the work body **106** and the center body **104** together. This allows the work body **106** to rotate or pivot about or around a second axis extending through the work body apertures **128** and second aperture **120**. As illustrated, the first axis extending through the drive body apertures **112** and first aperture **118**, and second axis extending through the work body apertures **128** and second aperture **120** are perpendicular to each other or angularly disposed by about 90 degrees with respect to one another. The work body **106** also further includes a work body axial bore **130** adapted to receive the stiffening member **116**.

(17) The stiffening member **116** is disposed in the drive body axial bore **114**, the center body axial bore **122**, and the work body axial bore **130**, thereby allowing the stiffening member **116** to be inserted and extend through all three bodies. The stiffening member **116** is adapted to retain a shape set by a user. For example, the user can rotate or pivot the drive body **102** with respect to the center body **104** to a first desired angular portion, and the stiffening member **116** retains the drive body **102** in that first desired position. Similarly, the user can rotate or pivot the work body **106** with respect to the center body **104** to a second desired angular portion, and the stiffening member **116** retains the work body **106** in that second desired position. The stiffening member **116** also restricts movement of the drive body **102** and work body **106** from the desired positions set by the user. This stiffening member **116** can be made of any material that sufficiently adds stiffness and flexibility to allow the drive body **102** and the work body **106** to be rotated or pivoted to desired positions and retain the desired positions and/or restrict movement from the desired position/angle set by the user. The stiffening member **116** can be, for example, a tension rod. Accordingly, tension rods having varying stiffness may be used or be replaceable to allow adjustability of the stiffness. In another example, the stiffening member **116** may be in the form of an adjustable tension rod with adjustable spring tension to allow for adjustability of the stiffness.

(18) In another embodiment, as shown in FIGS. **4** and **5**, a tool adapter assembly **200**, such as, for example, a socket or socket adapter, having a drive body **202**, a center body **204**, and a work body **206** (which are substantially similar to the drive body **102**, the center body **104**, and the work body **106** described above) Similar to the tool adapter assembly **100** described above, the drive body **202** is rotatably or pivotably coupled to the center body **204** via a first fastener **232**, and the work body **206** is rotatably or pivotably coupled to the center body **204**, using a second fastener **234**. The first **232** and second **234** fasteners can be, for example, screws, rivets, welded pins, etc. Accordingly, the drive body **202** and the work body **206** can be adjusted in a number of positions/angles relative to one another by a user.

(19) Similar to the drive body **102** described above, the drive body **202** includes a female aperture **208**, for example, a square shaped bore, that is adapted to be releasably mated with a square male lug of a torque application tool, for example a ratchet or torque wrench or a breaker bar. The female aperture **208** can further include an indent **210** disposed on one or more inner surfaces thereof that is adapted to detainably engage an outwardly biased ball disposed on the male lug of the tool. However, the invention is not limited as such and other means of releasably mating the drive body **202** to the lug of the tool can be used, such as, for example, a snap-ring, friction fit, etc. can be used Similar to the drive body **102** described above, the drive body **202** further includes one or more drive body apertures **212** adapted to receive the first fastener **232** to rotatably couple the drive body **202** to the center body **204**.

(20) Similar to the center body **104** described above, the center body **204** includes first **218** and second **220** center body apertures adapted to respectively receive the first **232** and second **234** fasteners, and a center body axial bore **222** adapted to receive, for installation, a biasing member **236**, which will be described in more detail below. In this embodiment, the first **218** and second **220** center body apertures are slotted (as illustrated) or otherwise slightly larger in diameter than the first **232** and second **234** fasteners. The first **218** and second **220** center body apertures may also be offset or angularly disposed by about 90 degrees with respect to each other. The drive body apertures **212** of the drive body **202** are aligned with opposing ends of the first aperture **218**, and the first fastener **232** is disposed in the drive body apertures **212** and first aperture **218** to couple the drive body **202** and the center body **204** together. This allows the drive body **202** to rotate or pivot about or around a first axis extending through the drive body apertures **212** and first aperture **218**.

(21) Similar to the work body **106** described above, the work body **206** is adapted to engage a working piece, for example, a socket or fastener. In an embodiment, the tool assembly **200** is a socket adapter Similar to the work body **106** described above, the work body **206** includes a work body lug **224** and an outwardly biased ball disposed on the work body lug **224** to releasably mate

with, for example, a socket. However, the invention is not limited as such and other means of releasably mating to the work piece, such as, for example, a friction ring can be used. In this example, the work body lug **224** is square, although the invention is not limited as such. In an alternative embodiment (not shown), the tool assembly **200** is a socket. In this embodiment, the work body **206** includes a female aperture adapted to engage a head of a fastener, for example a bolt.

(22) Similar to the work body **106** described above, the work body **206** includes one or more work body apertures **228** adapted to receive the second fastener **234** to rotatably couple the work body **206** to the center body **204**. For example, the work body apertures **228** are aligned with opposing ends of the second aperture **220**, and the second fastener **234** is disposed in the work body apertures **228** and second aperture **220** to couple the work body **206** and the center body **204** together. This allows the work body **206** to rotate or pivot about or around a second axis extending through the work body apertures **228** and second aperture **220**. As illustrated, the first axis extending through the drive body apertures **212** and first aperture **218**, and second axis extending through the work body apertures **228** and second aperture **220** are perpendicular to each other or angularly disposed by about 90 degrees with respect to one another.

(23) The biasing member **236** is disposed in the center body **204** between the first **232** and second **234** fasteners, thereby causing the biasing member **236** to apply a biasing force to the first **232** and second **234** fasteners to push the first **232** and second **234** fasteners away from one another. The biasing member **236** biases the first fastener **232** to abut the first center body aperture **218** and biases the second fastener **234** to abut the second center body aperture **220**, thereby increasing friction between the first fastener **232** and the first center body aperture **218** and between the second fastener **234** and the second center body aperture **220**. The increased friction assists in retaining a position/angle of the drive body **202** and work body **206** set by a user. For example, the user can rotate or pivot the drive body **202** with respect to the center body **204** to a first desired angular portion, and the biasing member **236** and increased friction retains the drive body **202** in that first desired position Similarly, the user can rotate or pivot the work body **206** with respect to the center body **204** to a second desired angular portion, and the biasing member **236** and increased friction retains the work body **206** in that second desired position. The biasing member **236** and increased friction also restricts movement of the drive body **202** and work body **206** from the desired positions set by the user.

(24) In an embodiment, the biasing member **236** can be a coil spring(s), wave spring(s), Bellville washer(s), rubber, or other suitable compressible or elastomeric material for applying the biasing force. The biasing member **236** can be installed in the center body **204** by being inserted thereto via the center body axial bore **222**.

(25) In another embodiment, as shown in FIG. **6**, a tool adapter assembly **300**, such as, for example, a socket or socket adapter, having a drive body **302**, a center body **304**, and a work body **306** (which are substantially similar to the drive body **102**, the center body **104**, and the work body **106** described above) Similar to the tool adapter assembly **100** described above, the drive body **302** is rotatably or pivotably coupled to the center body **304** via a first fastener **332**, and the work body **306** is rotatably or pivotably coupled to the center body **304**, using a second fastener **334**. The first **332** and second **334** fasteners can be, for example, screws, rivets, welded pins, etc. Accordingly, the drive body **302** and the work body **306** can be adjusted in a number of positions/angles relative to one another by the user.

(26) Similar to the drive body **102** described above, the drive body **302** can include a female aperture that is substantially similar to the female aperture **108**. Similar to the drive body **102** described above, the drive body **302** further includes one or more drive body apertures **312** adapted to receive the first fastener **332** to rotatably couple the drive body **302** to the center body **304**.

(27) Similar to the center body **104** described above, the center body **304** includes first **318** and second **320** center body apertures adapted to respectively receive to the first **332** and second **334**

fasteners. In an embodiment, each of the first **318** and second **320** center body apertures are chamfered to respectively receive first **338** and second **340** rings, which will be discussed in more detail below.

(28) In an embodiment, the first **318** and second **320** center body apertures may be offset or angularly disposed by about 90 degrees with respect to each other. The drive body apertures **312** of the drive body **302** are aligned with opposing ends of the first aperture **318**, and the first fastener **332** is disposed in the drive body apertures **312** and first aperture **318** to couple the drive body **302** and the center body **304** together. This allows the drive body **302** to rotate or pivot about or around a first axis extending through the drive body apertures **312** and first aperture **318**.

(29) Similar to the work body **106** described above, the work body **306** is adapted to engage a working piece, for example, a socket or fastener. In an embodiment, the tool assembly **300** is a socket adapter Similar to the work body **106** described above, the work body **306** includes a work body lug **324** and an outwardly biased ball **326** disposed on the work body lug **324** to releasably mate with, for example, a socket. However, the invention is not limited as such and other means of releasably mating to the work piece, such as, for example, a friction ring, can be used. In this example, the work body lug **324** is square, although the invention is not limited as such. In an alternative embodiment (not shown), the tool assembly **300** is a socket. In an embodiment, the work body **306** includes a female aperture adapted to engage a head of a fastener, for example a bolt.

(30) Similar to the work body **106** described above, the work body **306** includes one or more work body apertures **328** adapted to receive the second fastener **334** to rotatably couple the work body **306** to the center body **304**. For example, the work body apertures **328** are aligned with opposing ends of the second aperture **320**, and the second fastener **334** is disposed in the work body apertures **328** and second aperture **320** to couple the work body **306** and the center body **304** together. This allows the work body **306** to rotate or pivot about or around a second axis extending through the work body apertures **328** and second aperture **320**. As illustrated, the first axis extending through the drive body apertures **312** and first aperture **318**, and second axis extending through the work body apertures **328** and second aperture **320** are perpendicular to each other or angularly disposed by about 90 degrees with respect to one another.

(31) The first ring **338** is disposed between the drive body **302** and the center body **304**, with the first fastener **332** extending through the first ring **338**. The second ring **340** is disposed between the work body **306** and the center body **304**, with the second fastener **334** extending through the second ring **340**. The first and second rings **338**/**340** respectively apply a compressive force and increase friction between the drive body **302** and the center body **304**, and between the work body **306** and the center body **304**. The compressive force and increased friction assists in retaining a shape set by a user. For example, the user can rotate or pivot the drive body **302** with respect to the center body **304** to a first desired angular portion, and the compressive force and increased friction caused by the first ring **338** retains the drive body **302** in that first desired position. Similarly, the user can rotate or pivot the work body **306** with respect to the center body **304** to a second desired angular portion, and the compressive force and increased friction caused by the second ring **340** retains the work body **306** in that second desired position. The compressive force and increased friction caused by the first and second rings **338**/**340** also restricts movement of the drive body **302** and work body **306** from the desired positions set by the user.

(32) The first **338** and second **340** rings can be made from an elastomer, for example rubber, or other suitable compressible or compressible material. If the first **332** and second **334** fasteners are threaded fasteners, for example screws, the first **338** and second **340** rings can be replaced should the rubber rings begin to wear or age. Accordingly, the entire assembly **300** will not need to be replaced. Additionally, the amount of compressive force and friction can be adjusted for optimal retention and joint stiffness by changing, for example, ring thickness, rubber durometer/stiffness, the elastomer compound, etc.

(33) In another embodiment, as shown in FIGS. **7** and **8**, a tool adapter assembly **400**, such as, for example, a socket or socket adapter, having a drive body **402**, a center body **404**, and a work body **406** (which are substantially similar to the drive body **302**, the center body **304**, and the work body **306** described above) Similar to the tool adapter assembly **300** described above, the drive body **402** is rotatably or pivotably coupled to the center body **404** via a first fastener **432**, and the work body **406** is rotatably or pivotably coupled to the center body **404**, using a second fastener **434**. The first **432** and second **434** fasteners are threaded fasteners, for example, screws. Accordingly, the drive body **402** and the work body **406** can be adjusted in a number of positions/angles relative to one another by the user.
(34) Similar to the drive body **102** described above, the drive body **402** can include a female aperture **408**, which is substantially similar to the female aperture **108**, and can be for example, a square shaped bore, that is adapted to be releasably mated with a square male lug of a torque application tool, for example, a ratchet or torque wrench or breaker bar. Similar to the female aperture **108** described above, the female aperture **408** can further include an indent **410** disposed on one or more inner surfaces thereof that is adapted to detainably engage an outwardly biased ball disposed on the male lug of the tool. However, the invention is not limited as such and other means of releasably mating the drive body **402** to the lug of the tool can be used, such as, for example, a snap-ring, friction fit, etc. can be used. Similar to the drive body **102** described above, the drive body **302** further includes one or more drive body apertures **412** adapted to receive the first fastener **432** to rotatably couple the drive body **402** to the center body **404**. In this embodiment, one of the drive body apertures **412** is threaded and adapted to threadably couple to the first fastener **432**.
(35) Similar to the center body **304** described above, the center body **404** includes first **418** and second **420** center body apertures adapted to respectively receive to the first **432** and second **434** fasteners. In this embodiment, a first shoulder **442** extends circumferentially within the first center body aperture **418**, and a second shoulder **444** extends circumferentially within the second center body aperture **420**. The first **418** and second **420** center body apertures may be offset or angularly disposed by about 90 degrees with respect to each other. The drive body apertures **412** of the drive body **402** are aligned with opposing ends of the first aperture **418**, and the first fastener **432** is disposed in the drive body apertures **412** and first aperture **418** to couple the drive body **402** and the center body **404** together. This allows the drive body **402** to rotate or pivot about or around a first axis extending through the drive body apertures **412** and first aperture **418**.
(36) Similar to the work body **106** described above, the work body **406** is adapted to engage a working piece, for example, a socket or fastener. In the present embodiment, the tool assembly **400** is a socket adapter Similar to the work body **306** described above, the work body **406** includes a work body lug **424** and an outwardly biased ball **426** disposed on the work body lug **424** to releasably mate with, for example, a socket. However, the invention is not limited as such and other means of releasably mating to the work piece, such as, for example, a friction ring, can be used. In this example, the work body lug **424** is square, although the invention is not limited as such. In an alternative embodiment (not shown), the tool assembly **400** is a socket. In an embodiment, the work body **406** includes a female aperture adapted to engage a head of a fastener, for example a bolt.
(37) Similar to the work body **306** described above, the work body **306** includes one or more work body apertures **428** adapted to receive the second fastener **434** to rotatably couple the work body **406** to the center body **404**. In an embodiment, one of the work body apertures **428** is threaded and adapted to threadably couple to the second fastener **434**. For example, the work body apertures **428** are aligned with opposing ends of the second aperture **420**, and the second fastener **434** is disposed in the work body apertures **428** and second aperture **420** to couple the work body **406** and the center body **404** together. This allows the work body **406** to rotate or pivot about or around a second axis extending through the work body apertures **428** and second aperture **420**. As illustrated, the first axis extending through the drive body apertures **412** and first aperture **418**, and

second axis extending through the work body apertures **428** and second aperture **420** are perpendicular to each other or angularly disposed by about 90 degrees with respect to one another.
(38) In an embodiment, the tool assembly **400** further includes first and second retaining members **446** respectively coupled to a first groove **448** disposed on the first fastener **432** and a second groove **450** disposed on the second fastener **434**. In an embodiment, the retaining members **446** are retaining rings.
(39) A first ring **438** is disposed within the first center body aperture **418** between the first retaining member **446** and the first shoulder **442**, with the first fastener **432** extending through the first retaining member **446** and the first ring **438**. A second ring **440** is disposed within the second center body aperture **420** between the second retaining member **446** and the second shoulder **444**, with the second fastener **434** extending through the second retaining member **446** and the second ring **440** Similar to the first **338** and second **340** rings described above, the first **438** and second **440** rings can be made from an elastomer, for example rubber, or other suitable compressible or elastomeric material. As the first fastener **432** is rotated in a clockwise or counterclockwise direction, an axial distance between the first retaining ring **446** and the first shoulder **442** is decreased, thereby applying a compressive force to the first ring **438** in an axial direction, which causes the first ring **438** to expand in a radial direction to increase friction between the first ring **438** and the center body **404** Similarly, as the second fastener **434** is rotated in a clockwise or counterclockwise direction, an axial distance between the second retaining ring **446** and the second shoulder **444** is decreased, thereby applying a compressive force to the second ring **440** in an axial direction, which causes the second ring **440** to expand in a radial direction to increase friction between the second ring **440** and the center body **404**. Accordingly, the amount of compressive force and friction can be adjusted without disassembly of the tool adapter assembly **400** for optimal retention and joint stiffness by rotation of the first **432** and second **434** fasteners.
(40) The compressive force and increased friction assists in retaining a shape set by a user. For example, the user can rotate or pivot the drive body **402** with respect to the center body **404** to a first desired angular portion, and the compressive force and increased friction caused by the first fastener **432**, first retaining ring **446**, first ring **438**, and the first shoulder **442** retains the drive body **402** in that first desired position Similarly, the user can rotate or pivot the work body **406** with respect to the center body **404** to a second desired angular portion, and the compressive force and increased friction caused by the second fastener **434**, second retaining ring **446**, second ring **440**, and the second shoulder **444** retains the work body **406** in that second desired position. The compressive force and increased friction also restricts movement of the drive body **402** and work body **406** from the desired positions set by the user.
(41) The ability of the tool adapter assemblies **100**, **200**, **300**, and **400** described herein to maintain angular position of the drive and work bodies with respect to the center body, allows the user to manipulate the positions to a desired position, and then “fish” the tool adapter assembly to a work piece, without the tool adapter assembly losing the desired shape.
(42) As used herein, the term “coupled” and its functional equivalents are not intended to necessarily be limited to direct, mechanical coupling of two or more components. Instead, the term “coupled” and its functional equivalents are intended to mean any direct or indirect mechanical, electrical, or chemical connection between two or more objects, features, work pieces, and/or environmental matter. “Coupled” is also intended to mean, in some examples, one object being integral with another object.
(43) The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation. While particular embodiments have been shown and described, it will be apparent to those skilled in the art that changes and modifications may be made without departing from the broader aspects of the inventors' contribution. The actual scope of the protection sought is intended to be defined in the following claims when viewed in their proper perspective based on the prior art.

Claims

1. A tool adapter assembly for a tool having a tool lug and adapted to engage a work piece, the tool adapter assembly comprising: a center body including an exterior surface having first and second center body apertures that are angularly offset by about 90 degrees relative to each other, wherein the first and second center body apertures are adapted to respectively receive first and second fasteners; a drive body rotatably coupled to the center body and adapted to engage the tool lug, wherein the drive body is rotatable relative to the center body to a first angular position; a work body rotatably coupled to the center body and adapted to engage the work piece, wherein the work body is rotatable relative to the center body to a second angular position; and a stiffening member disposed within the center, drive, and work bodies, wherein the stiffening member is adapted to selectively retain a shape holding the drive and work bodies respectively in the first and second angular positions, and the first and second angular positions are non-zero angles.
2. The tool adapter assembly of claim 1, wherein each of the center, drive, and work bodies includes an axial bore that is adapted to receive the stiffening member.
3. The tool adapter assembly of claim 1, wherein the drive body includes a female aperture that is adapted to releasably mate with the tool lug.
4. The tool adapter assembly of claim 3, wherein the female aperture includes an indent disposed on an inner surface thereof, and the indent is adapted to detainably engage an outwardly biased ball disposed on the tool lug.
5. The tool adapter assembly of claim 1, wherein the work body includes a work body lug that is adapted to releasably mate with the work piece.
6. The tool adapter assembly of claim 1, wherein the stiffening member is a tension rod.
7. The tool adapter assembly of claim 6, wherein a stiffness of the tension rod is adjustable.
8. The tool adapter assembly of claim 1, wherein the drive body is rotatably coupled to the center body by the first fastener.
9. The tool adapter assembly of claim 1, wherein the work body is rotatably coupled to the center body by the second fastener.
10. A tool adapter assembly for a tool having a tool lug, the tool adapter assembly comprising: a center body; a drive body rotatably coupled to the center body and adapted to engage the tool lug, wherein the drive body is rotatable relative to the center body to a first angular position; a work body rotatably coupled to the center body and adapted to engage a work piece, wherein the work body is rotatable relative to the center body to a second angular position; and a tension rod having a stiffness is disposed within the center, drive, and work bodies, wherein the tension rod is adapted to selectively retain a shape holding the drive and work bodies respectively in the first and second angular positions, wherein the first and second angular positions are non-zero angles, and the stiffness is adjustable.