A tool for removing a first flange from a second flange comprises a housing having a central axis, a first end, and an open second end opposite the first end. The housing also includes a first access port extending radially therethrough. In addition, the tool comprises an annular basket grapple coaxially disposed within the second end of the housing and configured to coaxially receive and engage a first flange. The basket grapple has a first end, a second end opposite the first end, and a cutout extending radially therethrough. The outer surface of the basket grapple includes external threads that engage mating internal threads on the inner surface of the housing. Further, the tool comprises a key releasably coupled to the housing. The key is configured to selectively prevent relative rotation between the basket grapple and the housing.
FLANGE OVERSHOT RETRIEVAL TOOL
CROSS-REFERENCE TO RELATED APPLICATIONS


STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

BACKGROUND

[0003] 1. Field of the Invention

[0004] The invention relates generally to remedial devices and methods for hydrocarbon drilling and production operations. More particularly, the invention relates to devices and methods for removing a flange subsea.

[0005] 2. Background of the Technology

[0006] In hydrocarbon drilling and production operations, it is common to have tubulars or pipes coupled together with mating flanges to form a flange joint. During maintenance and/or remedial operations, it may be necessary to separate the connected flanges to access passages or bores in the equipment, to advance other tools or devices through the equipment, to break down or remove the equipment, or to prepare one flange for connection to a different piece of equipment. For example, in the event of a subsea blowout, it may be necessary to separate a flanged connection between a riser and a riser flex joint so that a different piece of equipment can then be connected to the riser flex joint.

[0007] On land, such remedial operations may be relatively easy if the flange connection can be directly accessed and engaged at the surface with impact wrenches, tongs, or other suitable separation equipment. However, if the flange connection is remote from the associated surface operations (e.g., disposed downhole or subsea), it may be more difficult to sufficiently grasp and remove one flange of a flange connection from its mating flange.

[0008] Accordingly, there remains a need in the art for devices and methods to separate and remove a flange of a flange joint from its mating flange. Such devices and methods would be particularly well-received if they were suitable for remote, subsea remedial operations.

BRIEF SUMMARY OF THE DISCLOSURE

[0009] These and other needs in the art are addressed in one embodiment by a tool for removing a first flange from a second flange. In an embodiment, the tool comprises a housing having a central axis, a first end, an open second end opposite the first end, a radially inner surface, and a radially outer surface. The housing also includes a first access port extending radially from the outer surface to the inner surface. In addition, the tool comprises an annular basket grapple coaxially disposed within the second end of the housing and configured to coaxially receive and engage a first flange. The basket grapple has a first end, a second end opposite the first end, a radially inner surface, a radially outer surface, and a cutout extending radially through the basket grapple from the outer surface to the inner surface. The outer surface of the basket grapple includes external threads that engage mating internal threads on the inner surface of the housing. Further, the tool comprises a key releasably coupled to the housing. The key has a first position extending radially through the access port and the cutout, and a second position removed from the cutout. The key is configured to prevent relative rotation between the basket grapple and the housing in the first position and allow relative rotation between the basket grapple and the housing in the second position.

[0010] These and other needs in the art are addressed in another embodiment by a method for removing a first flange of a subsea flange joint from a second flange of the subsea flange joint. In an embodiment, the method comprises (a) positioning a flange overshot retrieval tool over the subsea flange joint. The tool comprises a housing having a central axis, a first end, an open second end opposite the first end, a radially inner surface, and a radially outer surface. The tool also comprises an annular basket grapple coaxially threaded into the second end of the housing. The basket grapple has a first end, and a second end opposite the first end. In addition, the method comprises (b) receiving the first flange into the basket grapple. Further, the method comprises (c) radially expanding the basket grapple during (b). Still further, the method comprises (d) removing the first flange from the flange joint after (b).

[0011] These and other needs in the art are addressed in another embodiment by a method. In an embodiment, the method comprises (a) lowering a flange overshot retrieval tool to a subsea flange joint including a first flange coupled to a second flange. The tool also comprises an annular basket grapple coaxially disposed in the second end of the housing. The basket grapple has a first end, and a second end opposite the first end. In addition, the method comprises (b) lowering the tool onto the first flange. Further, the method comprises (c) capturing the first flange with the basket grapple during (b). Still further, the method comprises releasing the first flange from the basket grapple subsea after (c).

[0012] Thus, embodiments described herein comprise a combination of features and advantages intended to address various shortcomings associated with certain prior devices, systems, and methods. The various characteristics described above, as well as other features, will be readily apparent to those skilled in the art upon reading the following detailed description, and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] For a detailed description of the preferred embodiments of the invention, reference will now be made to the accompanying drawings in which:

[0014] FIG. 1 is a partial cross-sectional perspective view of an embodiment of a flange overshot tool in accordance with the principles described herein;

[0015] FIG. 2 is a partial cross-sectional view of the tool of FIG. 1 engaging an upper flange of a flange joint;

[0016] FIG. 3 is a cross-sectional view of the tool of FIG. 1;

[0017] FIG. 4 is a perspective view of the tool of FIG. 1 illustrating a first release mechanism for releasing a flange;

[0018] FIG. 5 is a perspective view of the basket grapple of FIG. 1 engaging the upper flange of FIG. 2;

[0019] FIGS. 6A-6D are schematic sequential views of the tool of FIG. 1 being deployed subsea to remove the upper flange from the flange joint of FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The following discussion is directed to various embodiments of the invention. Although one or more of these
embodiments may be preferred, the embodiments disclosed should not be interpreted, or otherwise used, as limiting the scope of the disclosure, including the claims. In addition, one skilled in the art will understand that the following description has broad application, and the discussion of any embodiment is meant only to be exemplary of that embodiment, and not intended to intimate that the scope of the disclosure, including the claims, is limited to that embodiment.

[0021] Certain terms are used throughout the following description and claims to refer to particular features or components. As one skilled in the art will appreciate, different persons may refer to the same feature or component by different names. This document does not intend to distinguish between components or features that differ in name but not function. The drawing figures are not necessarily to scale. Certain features and components herein may be shown exaggerated in scale or in somewhat schematic form and some details of conventional elements may not be shown in interest of clarity and conciseness.

[0022] In the following discussion and in the claims, the terms “including” and “comprising” are used in an open-ended fashion, and thus should be interpreted to mean “including, but not limited to . . .”. Also, the term “couple” or “couples” is intended to mean either an indirect or direct connection. Thus, if a first device couples to a second device, that connection may be through a direct connection, or through an indirect connection via other devices, components, and connections. In addition, as used herein, the terms “axial” and “axially” generally mean along or parallel to a central axis (e.g., central axis of a body or a port), while the terms “radial” and “radially” generally mean perpendicular to the central axis. For instance, an axial distance refers to a distance measured along or parallel to the central axis, and a radial distance means a distance measured perpendicular to the central axis.

[0023] Referring now to FIGS. 1-4, an embodiment of a flange overshot tool 100 is shown. In general, tool 100 is employed to separate and retrieve a flange from a flange joint or connection (e.g., subsea flange joint or downhole flange joint). For example, in FIGS. 2 and 3, a subsea flange joint 200 including a first or upper flange 201 and a second or lower flange 202 is shown. Tool 100 is used to engage, lift, and remove upper flange 201 from lower flange 202 for subsequent operations. In this embodiment, tool 100 includes an outer surface 121 and includes a housing 110, a connection sub 140 coupled to housing 110, and a basket grapple 160 at least partially disposed within housing 110.

[0024] Referring still to FIGS. 1-4, housing 110 has a central or longitudinal axis 115 coincident with axis 105, a first or upper end 110a, and a second or lower end 110b opposite upper end 110a. A plate 150 including a plurality of holes extends across upper end 110a, however, lower end 110b is open. In this embodiment, housing 110 comprises a first or upper sub-housing 120 and a second or lower sub-housing 130 mounted to upper housing 120. Upper sub-housing 120 and lower sub-housing 130 are coaxially aligned, each having a central or longitudinal axis coincident with axes 105, 115.

[0025] Upper sub-housing 120 has a first or upper end 120a, a second or lower end 120b, a radially inner cylindrical surface 121, and a radially outer cylindrical surface 122. Upper end 120a comprises an annular flange 123 extending radially inward from surface 121, and lower end 120b comprises an annular flange 124 extending radially outward from outer surface 122. Upper flange 123 defines an annular shoulder 123a along inner surface 121 at upper end 120a, and lower flange 124 defines an annular shoulder 124a along outer surface 122 at lower end 120b. In addition, sub-housing 120 includes a plurality of circumferentially spaced through holes or apertures 126 axially positioned between flanges 123, 124. Each aperture 126 has a longitudinal axis 126a and extends radially through sub-housing 120 from inner surface 121 to outer surface 122. In this embodiment, apertures 126 are generally rectangular and oriented with axes 126a parallel to axes 105, 115. As will be described in more detail below, apertures 126 allow fluid to flow radially through sub-housing 120. Thus, for example, fluid within sub-housing 120 may flow through apertures 126 to the region outside sub-housing 120 and tool 100.

[0026] Referring still to FIGS. 1-4, cylindrical plate 150 is coaxially disposed within upper sub-housing 120. Plate 150 has a planar upper surface 151 oriented perpendicular to axis 105 and a planar lower surface 152 oriented parallel to upper surface 151. Plate 150 engages annular shoulder 123a and is attached to upper sub-housing 120 (e.g., plate 150 may be welded to sub-housing 120). In particular, plate 150 is fixed to upper sub-housing 120 such that plate 150 does not move translationally or rotationally relative to upper sub-housing 120.

[0027] In this embodiment, plate 150 includes a central through bore 154 coaxially aligned with axes 105, 115 and a plurality of circumferentially spaced through bores 155 disposed about bore 154. Each bore 154, 155 extends axially through plate 150 from upper surface 151 to lower surface 152. Connection sub 140 extends coaxially through central bore 154. As will be described in more detail below, radially outer bores 155 allow fluid to flow axially through plate 150. Thus, for example, fluid within sub-housing 120 may flow axially through bores 155 to the region outside sub-housing 120 and tool 100.

[0028] As best shown in FIG. 3, connection sub 140 is an elongate member having a central or longitudinal axis 145 coaxially aligned with axes 105, 115, a first or upper end 140a distal (i.e., away from) upper sub-housing 120, a second or lower end 140b extending into upper sub-housing 120, and a radially outer surface 141 extending between ends 140a, b. Outer surface 141 includes an annular shoulder 143 proximal (i.e., at or near) lower end 140b that engages lower surface 152 of plate 150. In this embodiment, upper end 140a comprises a box end 142 adapted to receive a mating pin end at the lower end of a pipe string (e.g., drill string) for deploying tool 100.

[0029] Sub 140 is disposed within bore 154 and is rigidly attached to plate 150 (e.g., sub 140 may be welded to plate 150). In particular, sub 140 is fixed to plate 150 such that sub 140 does not move translationally or rotationally relative to plate 150.

[0030] Referring again to FIGS. 1 and 3, lower sub-housing 130 has a first or upper end 130a, a second or lower end 130b, a radially inner surface 131 extending axially between ends 130a, b, and a radially outer cylindrical surface 132 extending axially between ends 130a, b. Upper end 130a comprises an annular flange 133 extending radially inward from surface 131. Flange 133 defines an annular shoulder 133a along inner surface 131 at upper end 130a.

[0031] Inner surface 131 includes an upper cylindrical portion 131a extending axially from upper flange 133 and a lower threaded portion 131b extending axially from lower end 130b. As seen more clearly in FIG. 3, upper portion 131a
of inner surface 131 engages lower flange 124 of upper sub-housing 120. As best shown in FIGS. 2 and 3, lower portion 131b includes internal threads 134 sized and configured to threadably engage basket grapple 160. As best shown in FIG. 3, in this embodiment, internal threads 134 defines a plurality of radially inner peaks 134a and a plurality of radially outer roots 134b axially positioned between peaks 134a. A frustoconical surface 135a extends from each peak 134a to a root 134b axially above the peak 134a, and an annular planar surface 135b oriented perpendicularly to axes 105, 115 extends radially outward from each peak 134a to a root 134b radially adjacent the peak 134a.

[0032] Lower sub-housing 130 is disposed about upper sub-housing 120. In particular, flange 133 of lower sub-housing 130 engages outer surface 122 of upper sub-housing 120, and flange 124 of upper sub-housing 120 engages cylindrical portion 131b of inner surface 131. Further, shoulders 124, 133a axially abut. Lower sub housing 130 is attached to upper sub-housing 120 (e.g., sub-housing 130 may be welded to sub-housing 120). In particular, sub-housing 130 is fixed to sub-housing 120 such that sub-housing 130 does not move translationally or rotationally relative to sub-housing 120.

[0033] In this embodiment, an annular weight 170 is coupled to lower sub-housing 130. Specifically, weight 170 is disposed about sub-housing 130 and includes a radially inner annular shoulder 171 that axially abuts and engages upper end 130a.

[0034] Referring again to FIGS. 1-4, a plurality of circumferentially spaced guide feet 180 are removable coupled to lower end 130b of sub-housing 130. Each foot 180 may be the same or different from one another. Specifically, each foot 180 has an upper end 180a radially adjacent outer surface 132, a lower end 180b distal (i.e., away from) sub-housing 130, and a radial extension or finger 181 axially positioned (relative to axes 105, 115) between ends 180a, b. Each finger 181 extends radially inward along lower end 130b and into lower sub-housing 130. As best shown in FIG. 2, fingers 181 define a plurality of circumferentially spaced shoulders 182 that extend radially inward from inner surface 131 at lower end 130b, thereby restricting and/or preventing basket grapple 160 from falling out of lower sub-housing 130.

[0035] Each foot 180 may be described as having a first or upper portion 183 extending between upper end 180a and finger 181 and a second or lower portion 184 extending between finger 181 and lower end 180b. Upper portion 183 of each foot 180 extends axially along outer surface 132 of lower sub-housing 130, and lower portion 184 of each foot 180 extends axially downward and radially outward from lower end 130b. As a result, lower portion of each foot 180 has a radially inner surface 185 that tapers axially downward and radially outward relative to sub-housing 130 and axes 105, 115. In particular, surface 185 of each foot 180 is oriented at an angle α measured from axes 105, 115 to surface 185 in side view (FIG. 2). Angle α is preferably between 30° and 60°. In this embodiment, angle α of each inner surface 185 is 45°. As will be described in more detail below, when tool 100 is lowered onto flange joint 200, feet 180, and more specifically surfaces 185, guide tool 100 into coaxial alignment with joint 200 for subsequent separation of flanges 201, 202. Accordingly, inner surfaces 185 may also be referred to as guide surfaces.

[0036] As best shown in FIGS. 2-4, in this embodiment, each foot 180 is coupled to lower sub-housing 130 with a bolt 187. In particular, sub-housing 130 includes a plurality of circumferentially spaced threaded bores 136 extending radially inward from outer surface 132 proximal (i.e., at or near) lower end 130b, and each foot 180 includes a through bore 186 extending radially through upper portion 183. Each bore 186 is circumferentially aligned with one bore 136, and a bolt 187 is passed through bore 136 and threaded into bore 186, thereby securing the corresponding foot 180 to lower sub-housing 130. In this embodiment, each bolt 187 includes a T-handle 188 that extends radially outward from sub-housing 130 and its corresponding foot 180. T-handles 188 enable rotation of bolts 187 with subsea remotely operated vehicles (ROVs), and enable subsea manipulation of tool 100 with subsea ROVs.

[0037] Referring now to FIGS. 1 and 4, lower sub-housing 130 includes an access port 138 axially positioned between weight 170 and feet 180. Port 138 extends radially through sub-housing 130 from inner surface 131 to outer surface 132. A rectangular access panel or door 190 is removable coupled to sub-housing 130 and is sized and configured to close port 138. In this embodiment, door 190 is coupled to sub-housing 130 with two bolts 187 as previously described. In particular, sub-housing 130 includes a pair of threaded bores 137 extending radially from outer surface 132 above and below port 138, and each door 190 includes a pair of through bores 191 extending radially therethrough. Bores 191 in each door 190 are aligned with bores 137 corresponding to port 138, and one bolt 187 is passed through each bore 191 and threaded into corresponding bore 137, thereby securing door 190 to lower sub-housing 130 over port 138.

[0038] As best shown in FIG. 4, in this embodiment, door 190 is a rectangular plate having a first surface 190a that faces and engages outer surface 132, and a second surface 190b parallel to inner surface 190a and facing away from sub-housing 130. A U-shaped handle 192 extends perpendicularly from second surface 190b of door 190. Handle 192 allows manipulation of door 190 with subsea ROVs during installation and removal of door 190. In addition, in this embodiment, door 190 includes a rectangular prismatic grapple key 193 extending perpendicularly from first surface 190a. Grapple key 193 is sized and configured to slidingly engage access port 138. With the associated door 190 secured to sub-housing 130, key 193 extends radially inward through access port 138 and basket grapple 160 disposed within sub-housing 130. In this embodiment, handle 192 and key 193 are each integral with door 190.

[0039] Referring now to FIGS. 1, 3, and 5, basket grapple 160 is coaxially disposed within lower sub-housing 130 and has a first or upper end 160a, a second or lower end 160b, a radially inner surface 161 extending axially between ends 160a, b, and a radially outer surface 162 extending axially between ends 160a, b. Outer surface 162 includes external threads 163 sized and configured to mate with internal threads 134 of lower sub-housing 130. Specifically, external threads 163 define a plurality of radially outer peaks 163a and a plurality of radially inner roots 163b axially positioned between peaks 163a. A frustoconical surface 164a extends from each peak 163a to a root 163b axially below the peak 163a, and an annular planar surface 164b oriented perpendicularly to axes 105, 115 extends radially inward from each peak 163a to a root 163b radially adjacent the peak 163a. Surfaces 164a are radially opposed and generally parallel to surfaces 135a, and surfaces 164b are axially opposed and generally parallel to surfaces 135b,
radially overlap (i.e., peaks 134a extend to an innermost radius that is less than the outermost radius of peaks 163a).

Referring still to FIGS. 1, 3, and 5, inner surface 161 of basket grapple 160 includes an annular recess 165 extending axially from lower end 160b. Recess 165 defines an annular shoulder 166 on inner surface 161 axially positioned between ends 160a, b. As best shown in FIG. 1, within recess 165, inner surface 161 comprises internal threads 167 defining a plurality of teeth 167a configured to engage and “bite” the radially outer surface of flange 201 of joint 200.

As best shown in FIG. 5, basket grapple 160 also includes a plurality of circumferentially spaced, parallel through slots 168 and a cutout 169. Each slot 168 extends axially from lower end 160b to a terminus 168b axially positioned between shoulder 166 and end 160a, and extends radially through basket 160 from inner surface 161 to outer surface 162. Accordingly, slots 168 define a plurality of circumferentially spaced fingers 168c extending axially from terminus 168b to lower end 160b. Fingers 168c can be flexed radially inward and radially outward at lower end 160b by applying radial forces to fingers 168c. Threads 167 previouvsly described extend across fingers 168c, and thus, teeth 167a are disposed on fingers 168c.

Referring now to FIGS. 2, 3, and 5, depending on the relative positions of surfaces 135b, 164b and surfaces 135a, 164a, lower sub-housing 130 may be moved axially upward and downward relative to basket grapple 160. In particular, sub-housing 130 may be moved axially downward relative to basket grapple 160 until planar surfaces 135b, 164b engage, and sub-housing 130 may be moved axially upward relative to basket grapple 160 until surfaces 135a, 164a engage. After engagement of surfaces 135a, 164a, continued urging of sub-housing 130 axially upward relative to basket grapple 160 causes surfaces 135a to slidingly engage surfaces 164a, thereby flexing or camming fingers 168c radially inward at lower end 160b. When planar surfaces 135b, 164b are proximal or contact each other, a radial clearance is provided between frustoconical surfaces 135b, 164b.

Cutout 169 extends axially from upper end 160a, is circumferentially aligned with access port 138, and slidingly receives key 193 previously described. By positively engaging cutout 169, key 193 restricts and/or prevents basket grapple 160 from rotating relative to lower sub-housing 130 about axes 105, 115. However, when key 193 is radially withdrawn from cutout 169, basket grapple 160 is allowed to rotate relative to housing 110 about axes 105, 115. As best shown in FIG. 5, one slot 168 extends axially from lower end 160b to cutout 169. Thus, basket grapple 160 includes one cut extending completely therethrough and defining circumferentially adjacent ends 160c, d. This cut allows basket grapple 160 to radially expand until surfaces 135a, 164a contact, and allows basket grapple 160 to radially contract until ends 160c, d circumferentially abut. Due to the ability of fingers 168c to radially flex and basket grapple 160 to radially expand, basket grapple 160 may be described as having an “unexpanded” or “relaxed” state or position in which fingers 168c are not flexed radially outward and basket grapple 160 is not radially expanded, and an “expanded” or “flexed” state or position in which fingers 168c are flexed radially outward and/or basket grapple 160 is radially expanded via circumferential displacement of ends 160c, d. Basket grapple 160 is biased to the unexpanded position. Thus, when basket grapple 160 is in the expanded position, it seeks to return to the unexpanded position. In this sense, basket grapple 160 functions similar to a spring.

In general, the components of tool 100 (e.g., sub-housings 120, 130, connection sub 140, plate 150, basket grapple 160, etc.) may comprise any suitable material(s). These components preferably comprise strong, durable materials suitable for subsea use such as stainless steel.

Referring now to FIGS. 6A-6D, tool 100 is shown being deployed and operated subsea to engage, grip, and retrieve upper flange 201 of flange joint 200. In this embodiment, flange joint 200 forms the connection between a subsea flex joint 343 and the lower end of a riser 315. In particular, a subsea blowout preventer (BOP) 320 is mounted to a wellhead 330 at the sea floor 303, and a lower marine riser package (LMRP) 340 is secured to BOP 320. Riser 315 typically extends from LMRP 340 to a floating platform at the sea surface. However, as shown in FIG. 6, riser 315 has been severed proximal (i.e., at or near) joint 200. BOP 320 and LMRP 340 are configured to controllably seal wellbore 301 and contain hydrocarbons fluids therein. The upper end of LMRP 340 comprises riser flex joint 343 that allows riser 315 to deflect angularly relative to BOP 320 and LMRP 340 while hydrocarbon fluids flow from wellbore 301, BOP 320 and LMRP 340 into riser 315.

During a “kick” or surge of formation fluid pressure in wellbore 301, one or more rams of BOP 320 and/or LMRP 340 are normally actuated to seal in wellbore 301 and protect personnel and hardware upstream of BOP 320 and LMRP 340. However, in some cases, BOP 320 and/or LMRP 340 may not contain wellbore 301, which may result in the discharge of such hydrocarbon fluids subsea. The emitted hydrocarbons fluids form a subsea hydrocarbon plume 360.

For subsea deployment and operation, one or more remote operated vehicles (ROVs) are preferably employed to position and monitor tool 100. In this embodiment, three ROVs 350 are employed to position and monitor tool 100. Each ROV 350 includes an arm 351 having a claw 352, a subsea camera 353 for viewing the subsea operations (e.g., the relative positions of tool 100 and joint 200, the positions and movement of arms 350 and claws 352, etc.), and an umbilical 354. Streaming video and/or images from cameras 353 are communicated to the surface or other remote location via umbilical 354 for viewing on a live or periodic basis. Arms 351 and claws 352 are controlled via commands sent from the surface or other remote location to ROV 350 through umbilical 354.

Referring first to FIG. 6A, in this embodiment, a tubular pipe string 370 is removably secured to connection sub 140, thereby coupling tool 100 to string 370. Tool 100 is controllably lowered subsea with string 370, which extends from tool 100 to a surface vessel. A derrick or other suitable device mounted to the surface vessel is preferably employed to support, axially move tool 100 on string 370, and to rotate tool 100 with string 370. Although string 370 is employed to lower tool 100 in this embodiment, in other embodiments, tool 100 may be deployed subsea on wireline or cables. Using string 370, tool 100 is lowered subsea under its own weight from a location generally above and laterally offset from joint 200 and outside of plume 360. Lowering tool 100 laterally offset from joint 200 and outside plume 360 offers the potential to reduce the likelihood of damage to joint 200 if tool 100 is inadvertently dropped, improve visibility of tool 200, and reduce the potential for hydrate formation within tool 100.
Moving now to FIG. 6B, tool 100 is lowered laterally offset from joint 200 and outside of plume 360 until lower end 110b and guide feet 180 are slightly above joint 200. As tool 100 descends and approaches joint 200, ROVs 350 monitor the position of tool 100 relative to joint 200.

Next, referring to FIG. 3 and FIG. 6C, tool 100 is moved laterally into position immediately above joint 200 with housing 110 substantially coaxially aligned with joint 200. One or more ROVs 350 may utilize claws 352 and handles 188 on tool 100 to guide and position tool 100 relative to joint 200. Due to its own weight, tool 100 is substantially vertical, whereas joint 200 may be oriented at an angle relative to vertical. Thus, it is to be understood that perfect coaxial alignment of housing 110 and joint 200 may be difficult. With tool 100 positioned immediately above joint 200, and housing 110 and joint 200 generally coaxially aligned, string 370 sets tool 100 axially downward, thereby receiving upper flange 201 into lower sub-housing 130 and basket grapple 160. Prior to lowering tool 100 onto flange 201, the bolts securing flanges 201, 202 are removed such that flange 201 can be axially lifted and removed from flange 202 with tool 100 as will be described in more detail below. The bolts securing flanges 201, 202 may be removed by any suitable means including, without limitation, by an ROV operated torque tool.

As tool 100 is set down onto flange 201, feet 180, and in particular guide surfaces 185, help to guide and funnel upper flange 201 into lower end 110b of housing 110 and basket grapple 160. This may be particularly beneficial in cases where housing 110 is not perfectly coaxially aligned with joint 200 as tool 100 is lowered over upper flange 201. As tool 100 is positioned over joint 200 and lowered onto upper flange 201, apertures 126 in upper sub-housing 120 and bores 155 in plate 150 allow hydrocarbon fluids flowing from joint 200 to flow unrestricted through tool 100, thereby relieving well pressure and offering the potential to reduce the resistance to the coupling of tool 100 to flange 201. In addition, providing sufficient flow through area within tool 100 offers the potential to reduce the likelihood of hydrate formation within tool 100 and enhance visibility of tool 100. Although embodiments of tool 100 and the methods of using same described herein offer the potential to reduce hydrate formations and enhance visibility when employed to remove flange 201 from flange joint 200 that is emitting hydrocarbons, it should be appreciated that embodiments described herein may also be employed to remove a flange from a flange joint that is not emitting hydrocarbons.

As best shown in FIG. 5, basket grapple 160 is sized and configured such that the inner diameter of basket grapple 160 within recess 165 is about the same or slightly less than the outer diameter of upper flange 201 when basket grapple 160 is in its relaxed and unexpanded state. As a result, internal threads 167 and associated teeth 167a along the inner surface 161 of basket grapple 160 slidingly engage the radially outer surface of flange 201 as flange 201 is axially inserted into lower end 160b. In addition, basket grapple 160 is preferably sized and configured such that the axial height of recess 165 is the same as the axial height of upper flange 201. Upper flange 201 is preferably coaxially advanced into basket grapple 160 until flange 201 axially abuts and engages annular shoulder 166 on inner surface 161. Due to the relative sizes of upper flange 201 and basket grapple 160 in its relaxed state, basket grapple 160 may need to be urged axially downward to sufficiently seat flange 201 in basket grapple 160. Accordingly, housing 110 may be pushed axially downward and/or axially lifted and dropped one or more times after the initial engagement of basket grapple 160 and flange 201 to allow axial engagement of surfaces 135b, 164b to urge basket grapple 160 axially downward onto flange 201. As basket grapple 160 is tapped and/or urged axially downward by housing 110 onto flange 201, basket grapple 160 is transitioned to an expanded state in which fingers 168c are flexed radially outward and/or basket grapple 160 is radially expanded via circumferential displacement of ends 160c, 160d. Since basket grapple 160 is biased to the unexpanded position, internal threads 167 and associated teeth 167a are urged radially inward into engagement with flange 201 as flange 201 is seated in basket grapple 160.

Referring now to FIGS. 6C, 5, and 2, once flange 201 is sufficiently seated in basket grapple 160, housing 110 is lifted axially upward with string 370 relative to flange 201 and basket grapple 160 coupled thereto. As housing 110 is axially lifted, surfaces 135a, 164a come into contact. The continued application of axial lifting forces to housing 110 causes surfaces 135a to cam fingers 168c radially inward, thereby causing teeth 167a “bite” into and firmly grip the radially outer surface of flange 201 and allowing flange 201 to be lifted with tool 100 and removed from flange 202 as shown in FIG. 6D. With flange 201 removed from flange 202 and captive within basket grapple 160, tool 100 is lifted to the surface, where flange 201 may be removed from tool 100 with a spreader tool.

In some cases, tool 100 may not be able to remove upper flange 201 subsea once it is seated within basket grapple 160 and an axial lifting force is applied to housing 110. For example, upper flange 201 may be firmly seized or corroded onto lower flange 202. In such cases, it is generally desirable to remove tool 100 from upper flange 201 so that another tool or procedure may be employed to remove flange 201. Accordingly, in this embodiment, several options are provided to remove tool 100 from upper flange 201 once it has been seated within basket grapple 160.

Referring now to FIGS. 1, 2 and 6C, one option for disengaging upper flange 201 subsea involves the rotation of housing 110 and basket grapple 160 with pipe string 370 relative to flange 201 to unthread or back off tool 100 from flange 201. As previously described, connection sub 140, plate 150, upper sub-housing 120, and lower sub-housing 140 are fixably coupled such that they do not move translationally or rotationally relative to each other. Thus, rotation of string 370 causes housing 110 to rotate in the same direction about axes 105, 115. Basket grapple 160 is threaded into lower sub-housing 130, however, key 193 extending radially from door 190 into cutout 169 of basket grapple 160 prevents housing 110 from rotating relative to basket grapple 160. Thus, with key 193 extending through access port 138 and cutout 169, basket grapple 160 rotates along with housing 110 about axes 105, 115. Further, as previously described, teeth 167a engaging flange 201 are defined by internal threads 167. Thus, rotation of housing 110 and basket grapple 160 relative to flange 201 enables teeth 167a to be unthreaded and backed off flange 201. With basket grapple 160 unthreaded from flange 201, housing 110 and basket grapple 160 disposed therein may be lifted to the surface.

Referring now to FIGS. 1 and 6D, another option for disengaging upper flange 201 subsea involves the rotation of housing 110 with pipe string 370 relative to basket grapple 160 to unthread or back off housing 110 from basket grapple...
160. As previously described, rotation of string 370 causes housing 110 to rotate in the same direction about axes 105, 115. Basket grapple 160 is threaded into lower sub-housing 130 via mating threads 134, 163, however, key 193 extending radially through port 138 and cutout 169 of basket grapple 160 prevents housing 110 from rotating relative to basket grapple 160. Thus, to rotate housing 110 relative to basket grapple 160, ROVs 350 withdraw key 193 from cutout 169 by first unthreading bolts 187 coupling door 190 to lower sub-housing 130 via rotation of corresponding T-handles 188, and then pulling door 190 and key 193 from sub-housing 130 with handle 192.

[0057] As previously described, circumferentially spaced shoulders 182 defined by fingers 181 function to retain basket grapple 160 within sub-housing 130. Accordingly, guide feet 180 are also removed from sub-housing 130 to allow housing 110 to be completely unthreaded from basket grapple 160. ROVs 350 remove guide feet 180 by unthreading bolts 187 via rotation of corresponding T-handles 188.

[0058] Once key 193 is removed from cutout 169 and guide feet 180 have been removed from sub-housing 130, housing 110 is simultaneously moved axially downward relative to basket grapple 160 by string 370 or under its own weight, and rotated from the surface with string 370. As sub-housing 130 moves axially downward relative to basket grapple 160, surfaces 135a, 164b move together and surfaces 135a, 164a move apart, thereby removing the camming forces applied to fingers 168c by surfaces 135a and creating radial clearance between surfaces 135c, 164c. Since basket grapple 160 is secured to upper flange 201 via engagement of teeth 167a and flange 201, housing 110 is allowed to rotate relative to basket grapple 160. As a result, housing 110 is unthreaded and backed off basket grapple 160 and may be removed to the surface leaving basket grapple 160 behind. With housing 110 removed from basket grapple 160 and upper flange 201, basket grapple 160 can be directly accessed by ROVs 350 and removed from upper flange 201 (e.g., by cutting basket grapple 160 off flange 201).

[0059] Referring now to FIGS. 1 and 5, yet another option for disengaging upper flange 201 subsea involves the cutting of basket grapple 160 into multiple pieces. As previously described, basket grapple 160 is deployed with one through cut between ends 160c, d, thereby enabling basket grapple 160 to transition between an unexpanded state and an expanded state. As basket grapple 160 is urged onto upper flange 201, it is transitioned to its expanded state. Since basket grapple 160 is biased to its unexpanded or relaxed state, when it is expanded about flange 201, teeth 167a are biased radially inward into engagement with flange 201. However, by making a second through cut in basket grapple 160 opposite cutout 169 (i.e., ~180° from the original through cut), this biasing effect due to radial expansion of basket grapple 160 is removed and teeth 167a are not inherently urged radially inward into upper flange 201.

[0060] To access basket grapple 160 within housing 110 to create the second cut in basket grapple 160, ROVs 350 withdraw key 193 from cutout 169 by first unthreading bolts 187 coupling door 190 to lower sub-housing 130 via rotation of corresponding T-handles 188, and then pulling door 190 and key 193 from sub-housing 130 with handle 192. With key 193 removed from cutout 169, housing 110 is simultaneously moved axially downward relative to basket grapple 160 by string 370 or under its own weight, and rotated about 180° with string 370. Since basket grapple 160 is secured to upper flange 201 via engagement of teeth 167a and flange 201, housing 110 is allowed to rotate relative to basket grapple 160, thereby rotating a slot 168 that is positioned about 180° from cutout 169 and ends 160c, d into circumferential alignment with access port 138. Next, ROVs 350 access the slot 168 through port 135 and cut basket grapple 160 axially from upper end 160a to that slot 168, thereby dividing basket grapple 160 into two separate pieces, each extending about 180° about axes 105, 115. Next, housing 110 is slowly lifted axially upward with string 370. Since basket grapple 160 is cut into multiple pieces, it is loosely disposed about flange 201 and teeth 167a are not biased into positive engagement with flange 201. As a result, basket grapple 160 is lifted upward along with housing 110 from flange 201.

[0061] Referring now to FIGS. 4 and 6D, still yet another option for disengaging upper flange 201 subsea involves lifting housing 110 from basket grapple 160 and flange 201. As previously described, circumferentially spaced shoulders 182 defined by fingers 181 function to retain basket grapple 160 within sub-housing 130. Accordingly, guide feet 180 are removed from sub-housing 130 to allow housing 110 to be completely pulled upward from basket grapple 160. ROVs 350 remove guide feet 180 by unthreading bolts 187 via rotation of corresponding T-handles 188. It should be appreciated that key 193 need not be removed from cutout 169 and port 138 since it can be moved axially upward through cutout 169.

[0062] With feet 180 removed from housing 110, an axial lifting force is applied to housing 110 with string 140. Initially, the upward movement of housing 110 relative to basket grapple 160 cams fingers 168c radially inward, thereby causing teeth 167c to bite into flange 201. In general, the camming force applied to fingers 168c increases as the lifting force is increased. However, due to the relatively small radial overlap of threads 134, 163, at a sufficient lifting force, threads 134, 163 will plastically deform, thereby allowing housing 110 to be forcefully lifted from basket grapple 160. With housing 110 removed from basket grapple 160 and upper flange 201, basket grapple 160 can be directly accessed by ROVs 350 and removed from upper flange 201 (e.g., by cutting basket grapple 160 off flange 201).

[0063] Although tool 100 has been shown and described as being deployed on string 370, tool 100 may also be deployed on wireline or cable. However, it should be appreciated that wireline deployment may limit the ability to rotate housing 110 subsea, and thus, the options for releasing basket grapple 160 subsea that require rotation of housing 110 may not be available.

[0064] While preferred embodiments have been shown and described, modifications thereof can be made by one skilled in the art without departing from the scope or teachings herein. The embodiments described herein are exemplary only and are not limiting. Many variations and modifications of the systems, apparatus, and processes described herein are possible and are within the scope of the invention. For example, the relative dimensions of various parts, the materials from which the various parts are made, and other parameters can be varied. Accordingly, the scope of protection is not limited to the embodiments described herein, but is only limited by the claims that follow, the scope of which shall include all equivalents of the subject matter of the claims. Unless expressly stated otherwise, the steps in a method claim may be performed in any order. The recitation of identifiers such as (a), (b), (c) or (1), (2), (3) before steps in a method
claim are not intended to and do not specify a particular order to the steps, but rather are used to simplify subsequent reference to such steps.

What is claimed is:

1. A tool for removing a first flange from a second flange, the tool comprising:
   a housing having a central axis, a first end, an open second end opposite the first end, a radially inner surface, and a radially outer surface, wherein the housing includes a first access port extending radially from the outer surface to the inner surface;
   an annular basket grapple coaxially disposed within the second end of the housing and configured to coaxially receive and engage a first flange, wherein the basket grapple has a first end, a second end opposite the first end, a radially inner surface, a radially outer surface, and a cutout extending radially through the basket grapple from the outer surface to the inner surface;
   wherein the outer surface of the basket grapple includes external threads that engage mating internal threads on the inner surface of the housing; and
   a key releasably coupled to the housing, wherein the key has a first position extending radially through the first access port and the cutout, and a second position removed from the cutout, wherein the key is configured to prevent relative rotation between the basket grapple and the housing in the first position and allow relative rotation between the basket grapple and the housing in the second position.

2. The tool of claim 1, wherein the basket grapple includes a plurality of circumferentially spaced slots, wherein each slot extends axially from the second end of the basket grapple and extends radially through the basket grapple from the outer surface of the basket grapple to the inner surface of the basket grapple;
   wherein the plurality of slots define a plurality of circumferentially adjacent fingers configured to flex radially outward.

3. The tool of claim 2, wherein the cutout extends axially from the first end of the basket grapple and one of the plurality of slots extends axially from the second end of the basket grapple to the cutout.

4. The tool of claim 2, wherein the inner surface of the basket grapple includes a plurality of teeth positioned on each finger, wherein the teeth are configured to engage a first flange.

5. The tool of claim 1, further comprising a door releasably coupled to the housing and covering the first access port, wherein the key extends from the door.

6. The tool of claim 5, wherein the door is coupled to the housing with a bolt, wherein the bolt includes a handle extending radially from the housing, wherein the handle is configured to allow a remotely operated vehicle to remove the bolt and manipulate the position of the housing subsea.

7. The tool of claim 1, wherein the housing includes a plurality of circumferentially spaced through slots axially positioned between the first end of the housing and the basket grapple, wherein each through slot in the housing extends radially through the housing from the inner surface of the housing to the outer surface of the housing;
   wherein a plate is mounted to the first end of the housing, the plate including a plurality of circumferentially spaced through bores;
   wherein the through slots in the housing and the through bores in the plate are configured to allow fluid flow from the inside of the housing to the outside of the housing.

8. The tool of claim 1, further comprising a plurality of circumferentially spaced guide feet coupled to the second end of the housing, wherein each foot has a first end engaging the housing, a second end extending from the second end of the housing, and a guide surface extending from the second end of the foot.

9. The tool of claim 8, wherein each foot is removably coupled to the housing and includes a finger extending radially inward along the second end of the housing, wherein the fingers of the plurality of guide feet are configured to prevent the basket grapple from moving axially through the second end of the housing.

10. The tool of claim 9, wherein each guide foot is removably coupled to the housing with a bolt, wherein the bolt includes a handle extending radially from the housing, and wherein the handle is configured to allow a remotely operated vehicle to remove the bolt subsea.

11. A method for removing a first flange of a subsea flange joint from a second flange of the subsea flange joint, the method comprising:
   (a) positioning a flange overshot retrieval tool over the subsea flange joint, wherein the tool comprises:
      a housing having a central axis, a first end, an open second end opposite the first end, a radially inner surface, and a radially outer surface;
      an annular basket grapple coaxially threaded into the second end of the housing, wherein the basket grapple has a first end, and a second end opposite the first end;
   (b) receiving the first flange into the basket grapple;
   (c) radially expanding the basket grapple during (b); and
   (d) removing the first flange from the flange joint after (b).

12. The method of claim 11, further comprising:
   (e) preventing the rotation of the housing relative to the basket grapple with a key extending radially through the housing and the basket grapple.

13. The method of claim 11, wherein (b) further comprises guiding the first flange into the second end of the housing with a plurality of circumferentially spaced guide feet coupled to the second end of the housing;
   wherein each foot has a first end engaging the housing, a second end extending from the second end of the housing, and a guide surface extending axially downward and radially outward from the second end of the housing;
   wherein each guide foot includes a finger extending radially inward along the second end of the housing, wherein the fingers of the plurality of guide feet are configured to prevent the basket grapple from moving axially through the second end of the housing.

14. The method of claim 11, wherein the tool is positioned with a pipe string.

15. The method of claim 11, wherein the basket grapple further comprises a plurality of circumferentially spaced slots extending axially from the second end of the basket grapple;
   wherein the plurality of slots define a plurality of fingers at the second end of the basket grapple, each finger including a plurality of teeth disposed on the inner surface of the basket grapple;
   wherein (c) further comprises flexing the plurality of fingers radially outward during (b).
16. The method of claim 15, further comprising biasing the teeth radially inward into engagement with the first flange during (b).

17. A method comprising:
(a) lowering a flange overshot retrieval tool to a subsea flange joint including a first flange coupled to a second flange, wherein the tool comprises:
   a housing having a central axis, a first end, an open second end opposite the first end, a radially inner surface, and a radially outer surface;
   an annular basket grapple coaxially disposed in the second end of the housing, wherein the basket grapple has a first end, and a second end opposite the first end;
(b) lowering the tool onto the first flange;
(c) capturing the first flange with the basket grapple during (b); and
(d) releasing the first flange from the basket grapple subsea after (c).

18. The method of claim 17, wherein (a) comprises lowering the tool with a pipe string; and
wherein (d) further comprises:
   rotating the housing and the basket grapple relative to the first flange with the pipe string; and
   unthreading the basket grapple from the first flange.

19. The method of claim 17, wherein (a) comprises lowering the tool with a pipe string; and
wherein (d) further comprises:
   rotating the housing relative to the basket grapple and the first flange with the pipe string; and
   unthreading the housing from the basket grapple.

20. The method of claim 19, wherein (d) further comprises:
   removing a plurality of guide feet coupled to the second end of the housing with one or more subsea remotely operated vehicles;
   allowing the housing to rotate relative to the basket grapple by removing a key extending radially through the housing and the basket grapple with the one or more subsea remotely operated vehicles.

21. The method of claim 20, further comprising:
   (e) lifting the housing from the basket grapple and the first flange.

22. The method of claim 17, further comprising:
   rotating the housing relative to the basket grapple and the first flange with a pipe string;
   accessing the basket grapple subsea through a port extending radially through the housing; and
   cutting the basket grapple subsea through the port with a subsea remotely operated vehicles.

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