US 20120267116A1

(19) **United States**

(12) **Patent Application Publication**

Anderson

(10) **Pub. No.: US 2012/0267116 A1**

(43) **Pub. Date: Oct. 25, 2012**

(54) **FLANGE OVERSHOT RETRIEVAL TOOL**

(75) Inventor: **Paul Edward Anderson**, Peyton, CO (US)

(73) Assignee: **BP Corporation North America Inc.**, Houston, TX (US)

(21) Appl. No.: **13/455,806**

(22) Filed: **Apr. 25, 2012**

Related U.S. Application Data

(60) Provisional application No. 61/478,667, filed on Apr. 25, 2011.

Publication Classification

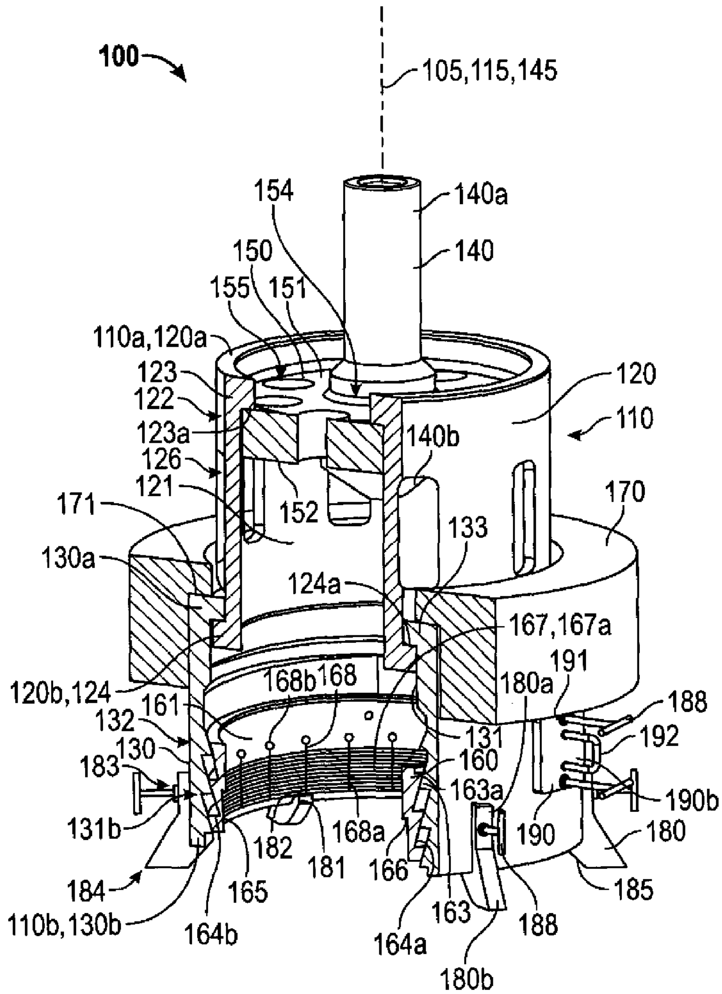
(51) **Int. Cl.**

E21B 19/16	(2006.01)
E21B 29/12	(2006.01)

(52) **U.S. Cl.** **166/340**; 166/85.1

(57) **ABSTRACT**

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.



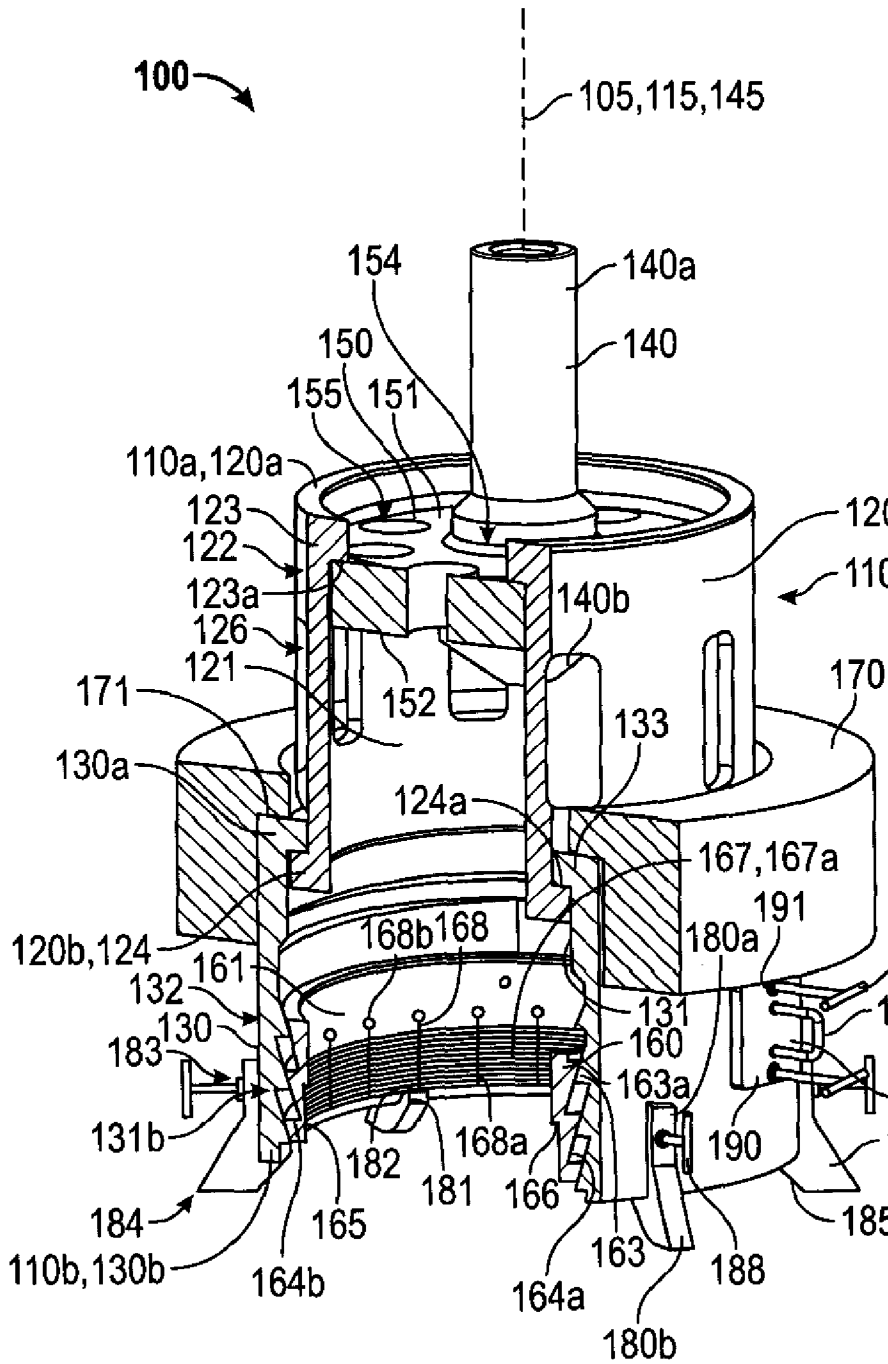

100
105,115,145
154
140a
150
140
155
151
110a,120a
123
120
122
110
123a
140b
126
121
171
152
170
133
130a
124a
167,167a
191
120b,124
168b
168
180a
188
132
161
131
192
130
160
183
163a
190b
131b
182
168a
190
180
181
166
184
165
185
163
188
110b,130b
164b
164a
180b

FIG. 1

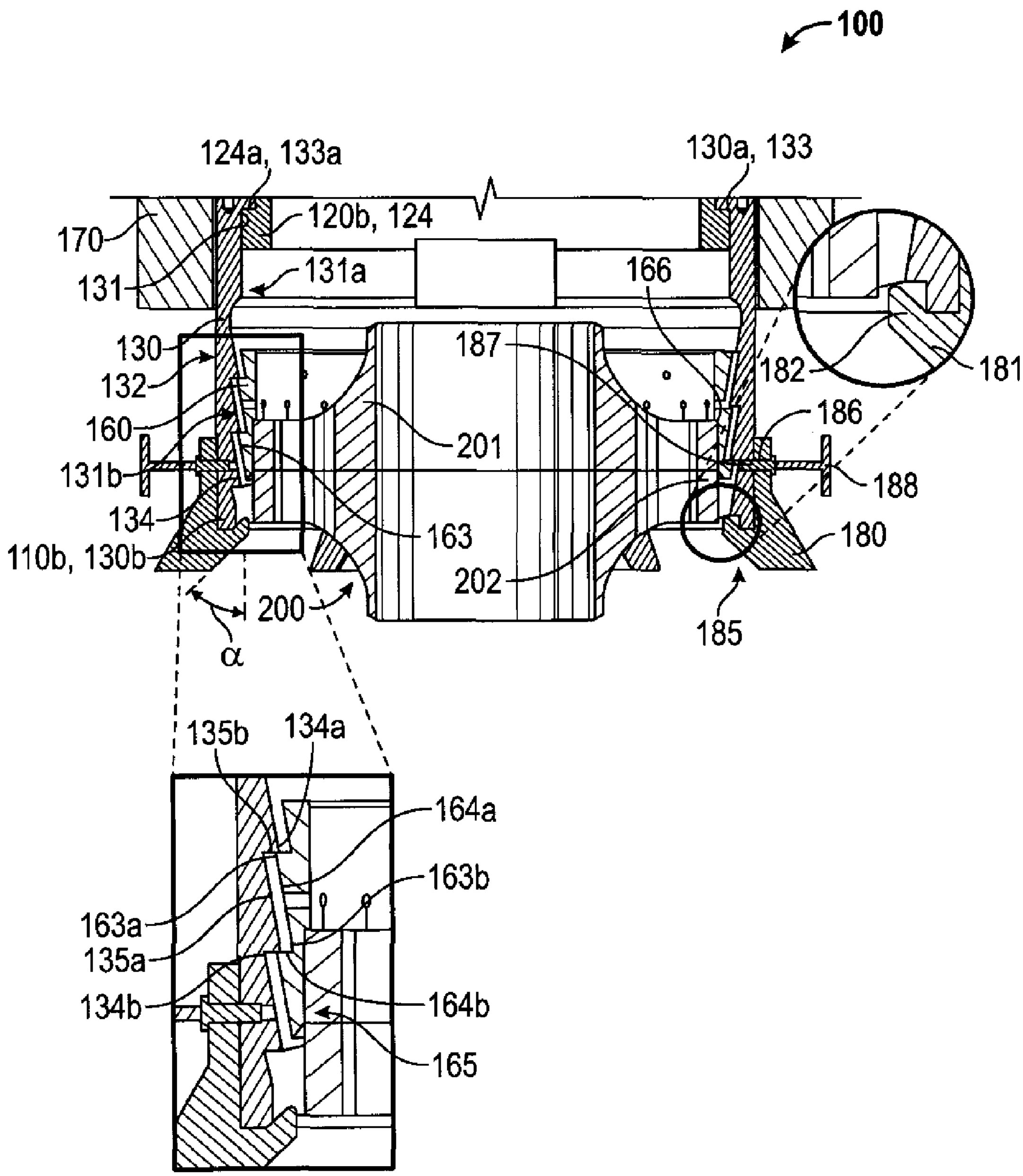

100
124a, 133a
130a, 133
170
120b, 124
131
131a
166
130
187
182
181
132
160
201
186
131b
188
134
163
180
110b, 130b
202
200
185
α
135b
134a
164a
163b
163a
135a
134b
164b
165

FIG. 2

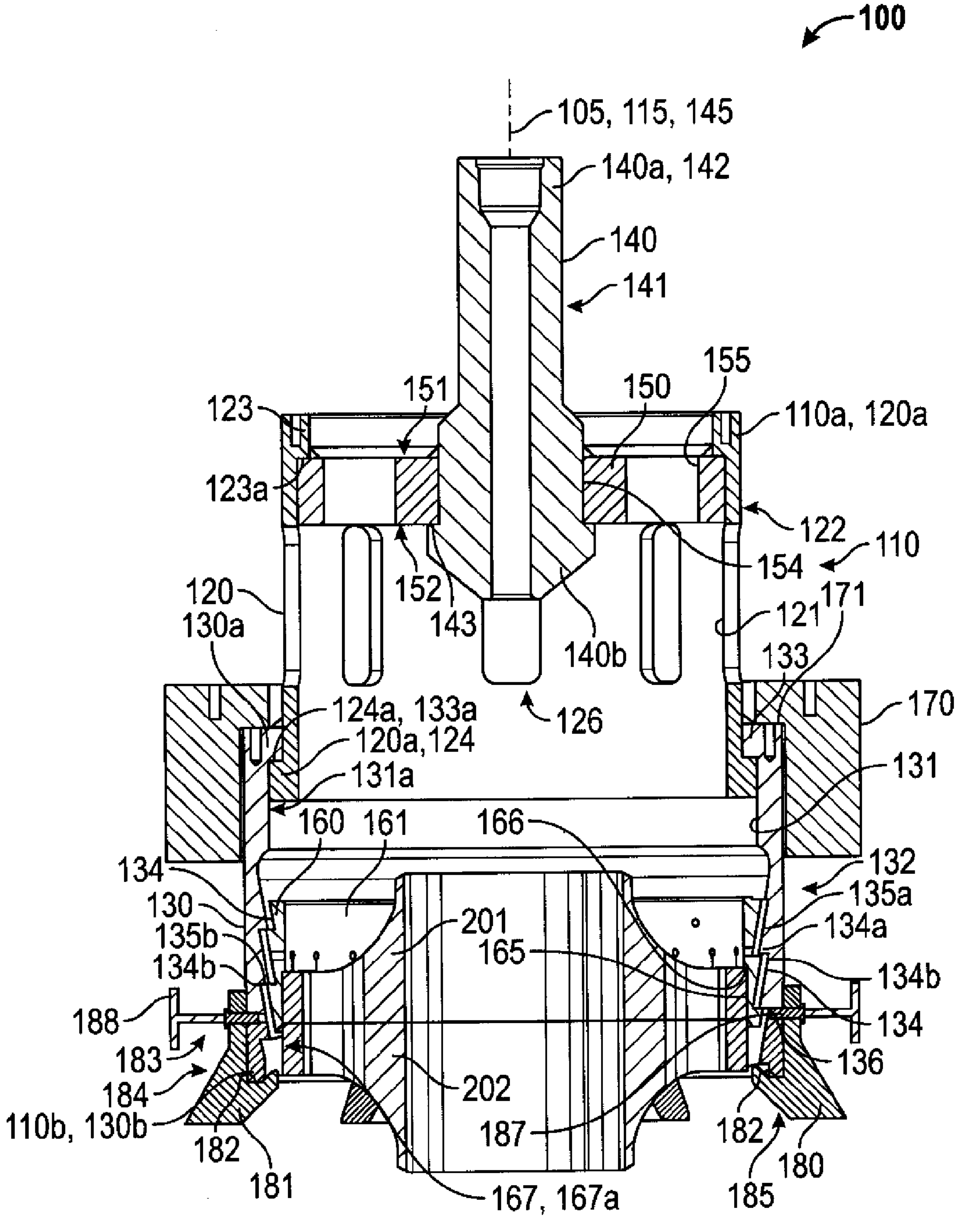

100
105, 115, 145
140a, 142
140
141
155
150
151
123
110a, 120a
123a
122
110
154
152
143
140b
120
130a
121
171
133
126
170
124a, 133a
120a,124
131a
131
160
161
166
134
132
130
135a
135b
201
134a
165
134b
134b
188
134
183
136
184
202
110b, 130b
182
187
182
180
181
167, 167a
185

FIG. 3

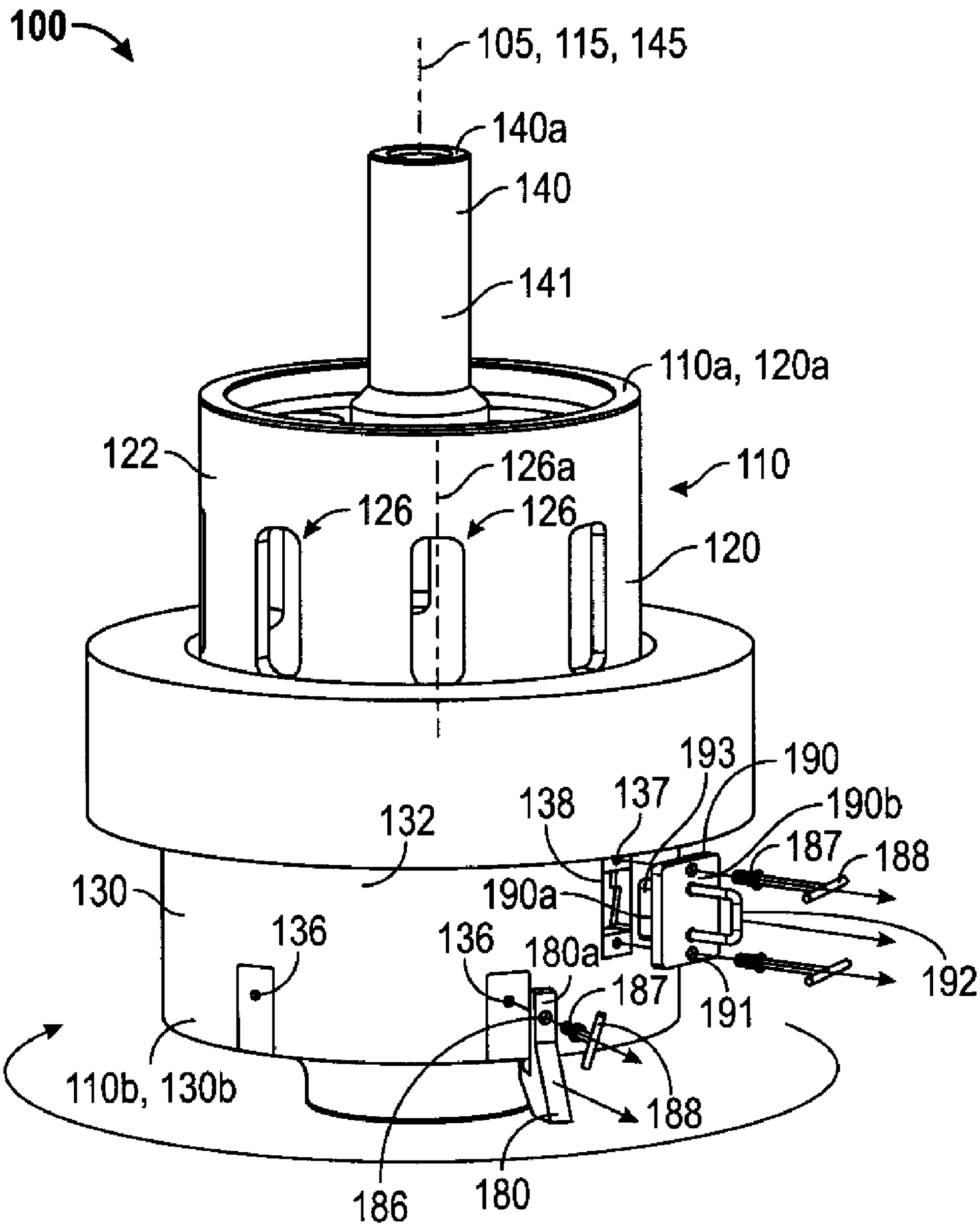

100
105, 115, 145
140a
140
141
110a, 120a
122
126a
110
126
126
120
193
190
138
137
190b
132
187
188
130
190a
136
136
180a
187
192
191
110b, 130b
188
186
180

FIG. 4

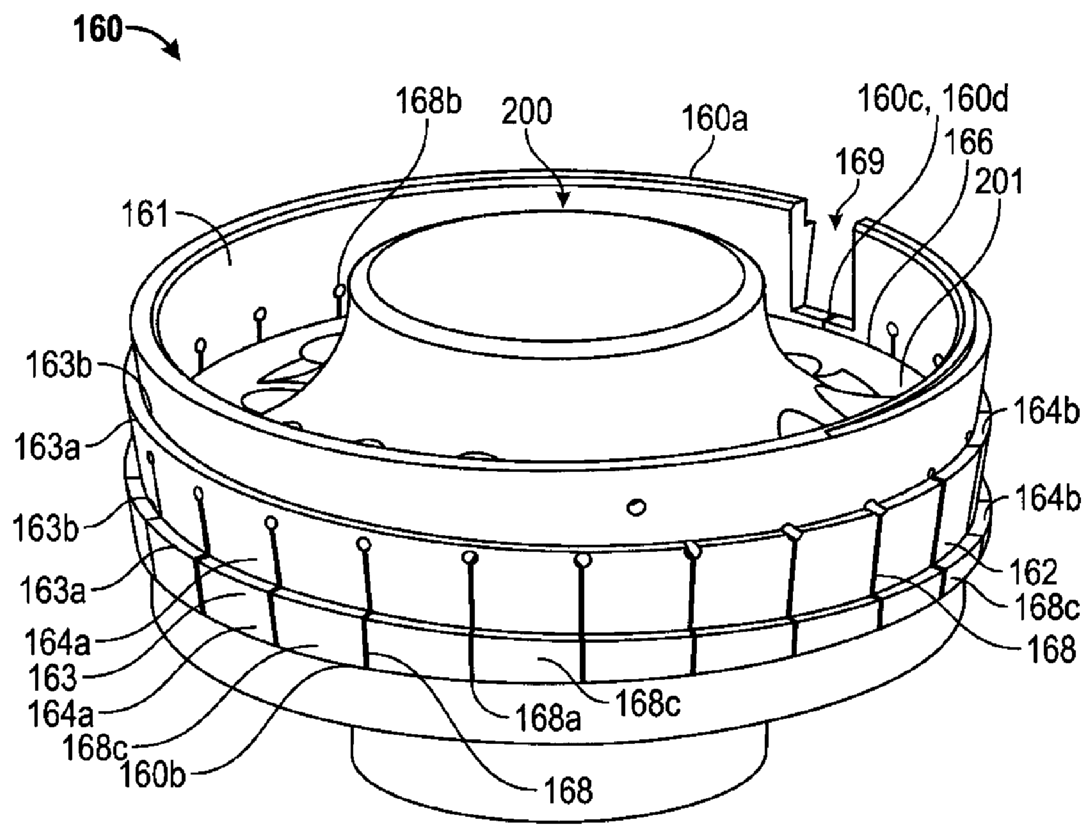

160
168b
200
160a
160c, 160d
166
169
201
161
163b
163a
164b
163b
164b
163a
162
168c
164a
168
163
164a
168a
168c
168c
160b
168

FIG. 5

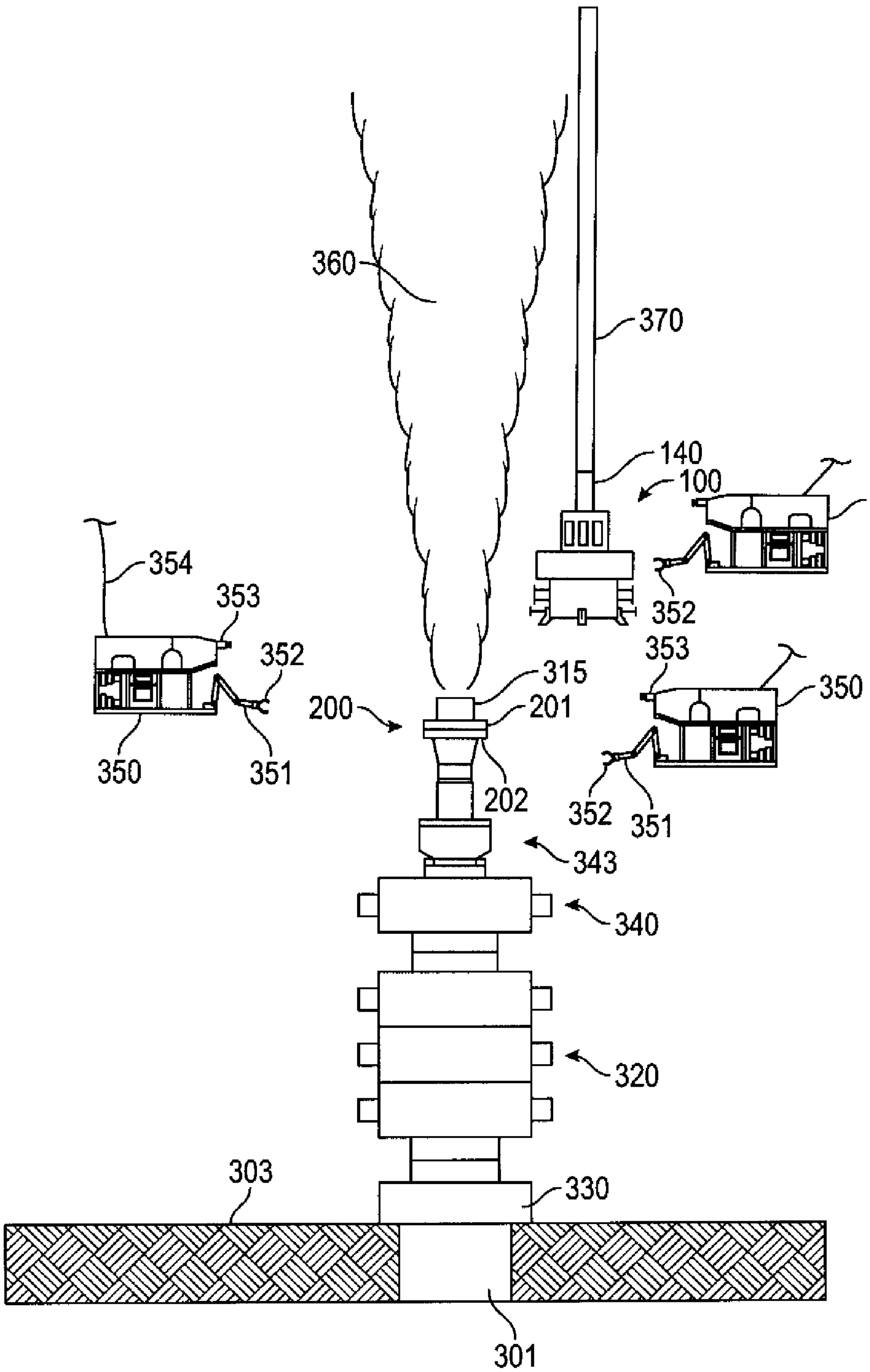

360
370
140
100
350
354
353
352
351
315
201
200
202
343
340
320
303
330
301

FIG. 6A

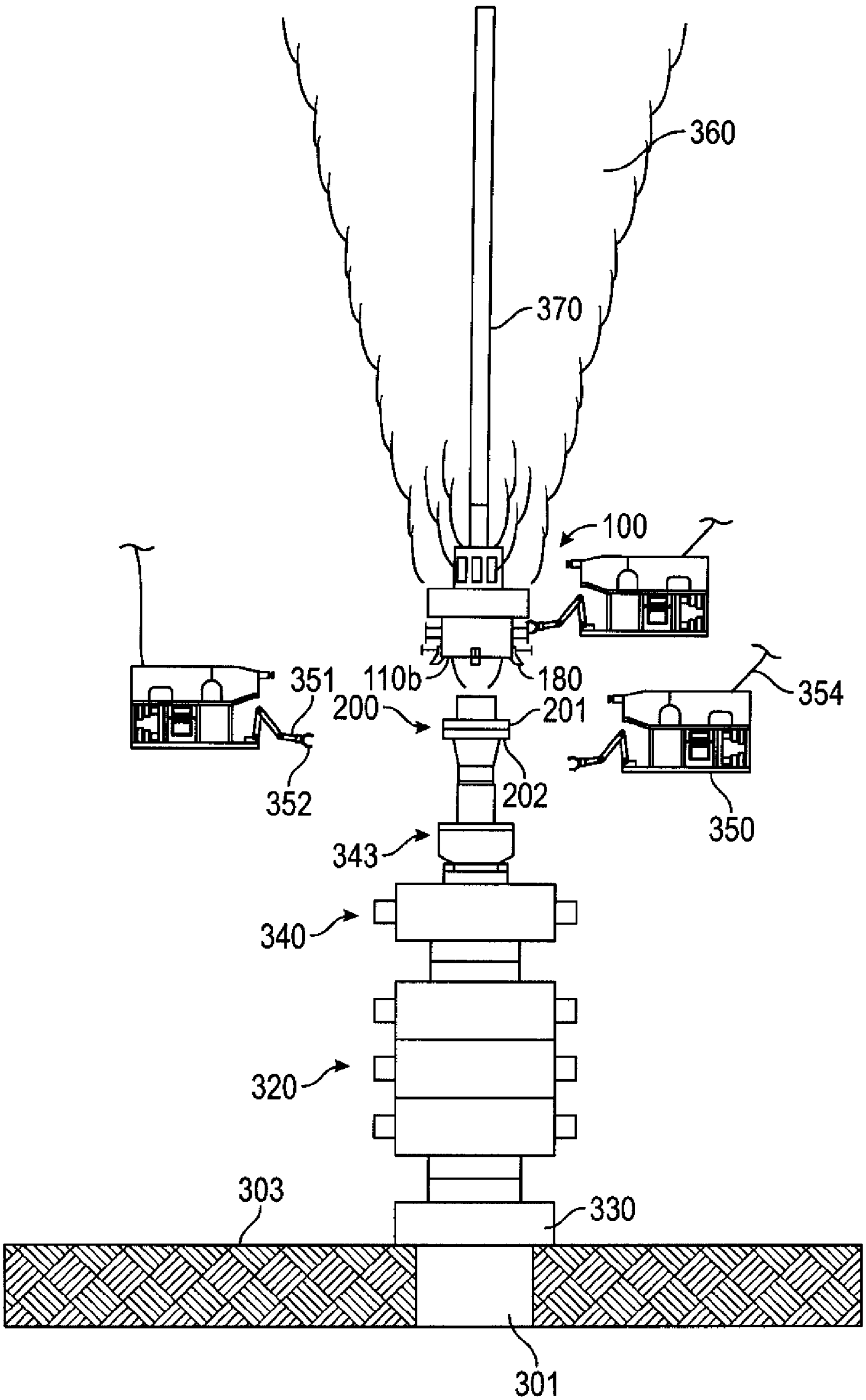

360
370
100
110b
180
351
354
200
201
352
202
350
343
340
320
303
330
301

FIG. 6B

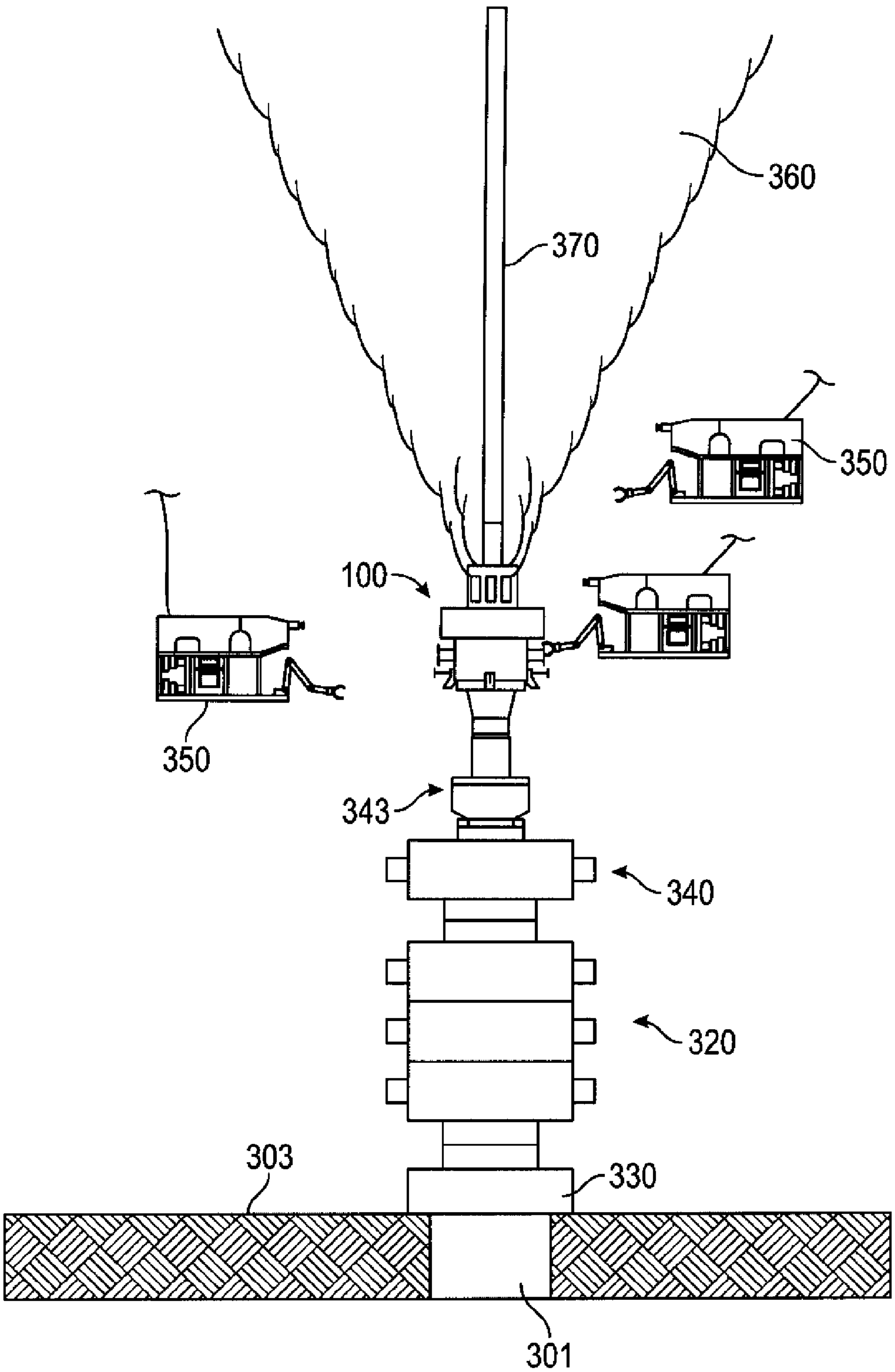


FIG. 6C

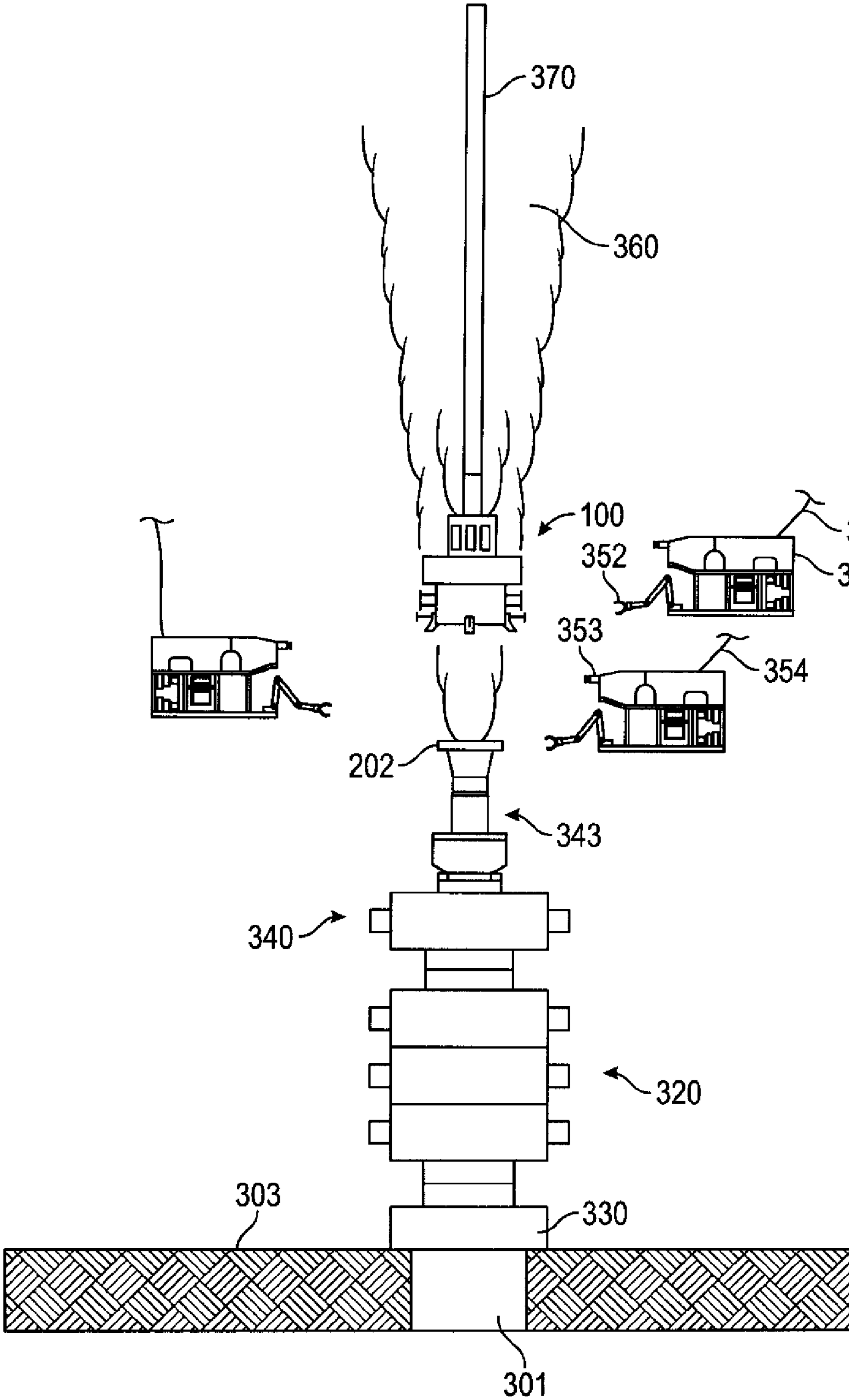


FIG. 6D

FLANGE OVERSHOT RETRIEVAL TOOL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit of U.S. provisional patent application Ser. No. 61/478,667 filed Apr. 25, 2011, and entitled "Flange Overshot Retrieval Tool," which is hereby incorporated herein by reference in its entirety.

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** has a central or longitudinal axis **105** 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 **110***a*, and a second or lower end **110***b* opposite upper end **110***a*. A plate **150** including a plurality of holes extends across upper end **110***a*, however, lower end **110***b* 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 **120***a*, a second or lower end **120***b*, a radially inner cylindrical surface **121**, and a radially outer cylindrical surface **122**. Upper end **120***a* comprises an annular flange **123** extending radially inward from surface **121**, and lower end **120***b* comprises an annular flange **124** extending radially outward from outer surface **122**. Upper flange **123** defines an annular shoulder **123***a* along inner surface **121** at upper end **120***a*, and lower flange **124** defines an annular shoulder **124***a* along outer surface **122** at lower end **120***b*. 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 **126***a* 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 **126***a* 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 **123***a* 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 **140***a* distal (i.e., away from) upper sub-housing **120**, a second or lower end **140***b* extending into upper sub-housing **120**, and a radially outer surface **141** extending between ends **140***a, b*. Outer surface **141** includes an annular shoulder **143** proximal (i.e., at or near) lower end **140***b* that engages lower surface **152** of plate **150**. In this embodiment, upper end **140***a* 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 **130***a*, a second or lower end **130***b*, a radially inner surface **131** extending axially between ends **130***a, b*, and a radially outer cylindrical surface **132** extending axially between ends **130***a, b*. Upper end **130***a* comprises an annular flange **133** extending radially inward from surface **131**. Flange **133** defines an annular shoulder **133***a* along inner surface **131** at upper end **130***a*.

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

[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 **131***b* of inner surface **131**. Further, shoulders **124**, **133***a* 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 **130***a*.

[0034] Referring again to FIGS. **1-4**, a plurality of circumferentially spaced guide feet **180** are removably coupled to lower end **130***b* of sub-housing **130**. Each foot **180** may the same or different from one another. Specifically, each foot **180** has an upper end **180***a* radially adjacent outer surface **132**, a lower end **180***b* distal (i.e., away from) sub-housing **130**, and a radial extension or finger **181** axially positioned (relative to axes **105**, **115**) between ends **180***a,b*. Each finger **181** extends radially inward along lower end **130***b* 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 **130***b*, 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 **180***a* and finger **181** and a second or lower portion **184** extending between finger **181** and lower end **180***b*. 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 **130***b*. 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 **130***b*, 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 removably 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 **190***a* that faces and engages outer surface **132**, and a second surface **190***b* parallel to inner surface **190***a* and facing away from sub-housing **130**. A U-shaped handle **192** extends perpendicularly from second surface **190***b* 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 **190***a*. 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 **160***a*, a second or lower end **160***b*, a radially inner surface **161** extending axially between ends **160***a, b*, and a radially outer surface **162** extending axially between ends **160***a, 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 **163***a* and a plurality of radially inner roots **163***b* axially positioned between peaks **163***a*. A frustoconical surface **164***a* extends from each peak **163***a* to a root **163***b* axially below the peak **163***a*, and an annular planar surface **164***b* oriented perpendicular to axes **105**, **115** extends radially inward from each peak **163***a* to a root **163***b* radially adjacent the peak **163***a*. Surfaces **164***a* are radially opposed and generally parallel to surfaces **135***a*, and surfaces **164***b* are axially opposed and generally parallel to surfaces **135***b*. Planar surfaces **135***b*,

164*b* radially overlap (i.e., peaks **134***a* extend to an innermost radius that is less than the outermost radius of peaks **163***a*).

[0040] 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 **160***b*. Recess **165** defines an annular shoulder **166** on inner surface **161** axially positioned between ends **160***a, b*. As best shown in FIG. **1**, within recess **165**, inner surface **161** comprises internal threads **167** defining a plurality of teeth **167***a* configured to engage and "bite" the radially outer surface of flange **201** of joint **200**.

[0041] 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 **160***b* to a terminus **168***b* axially positioned between shoulder **166** and end **160***a*, and extends radially through basket **160** from inner surface **161** to outer surface **162**. Accordingly, slots **168** define a plurality of circumferentially spaced fingers **168***c* extending axially from terminus **168***b* to lower end **160***b*. Fingers **168***c* can be flexed radially inward and radially outward at lower end **160***b* by applying radial forces to fingers **168***c*. Threads **167** previously described extend across fingers **168***c*, and thus, teeth **167***a* are disposed on fingers **168***c*.

[0042] Referring now to FIGS. **2**, **3**, and **5**, depending on the relative positions of surfaces **135***b*, **164***b* and surfaces **135***a*, **164***a*, 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 **135***b*, **164***b* engage, and sub-housing **130** may be moved axially upward relative to basket grapple **160** until surfaces **135***a*, **164***a* engage. After engagement of surfaces **135***a*, **164***a*, continued urging of sub-housing **130** axially upward relative to basket grapple **160** causes surfaces **135***a* to slidingly engage surfaces **164***a*, thereby flexing or camming fingers **168***c* radially inward at lower end **160***b*. When planar surfaces **135***b*, **164***b* are proximal or contact each other, a radial clearance is provided between frustoconical surfaces **135***b*, **164***b*.

[0043] Cutout **169** extends axially from upper end **160***a*, 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 **160***b* to cutout **169**. Thus, basket grapple **160** includes one cut extending completely therethrough and defining circumferentially adjacent ends **160***c, d*. This cut allows basket grapple **160** to radially expand until surfaces **135***a*, **164***a* contact, and allows basket grapple **160** to radially contract until ends **160***c, d* circumferentially abut. Due to the ability of fingers **168***c* 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 **168***c* are not flexed radially outward and basket grapple **160** is not radially expanded, and an "expanded" or "flexed" state or position in which fingers **168***c* are flexed radially outward and/or basket grapple **160** is radially expanded via circumferential displacement of ends **160***c, 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.

[0044] 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.

[0045] Referring now to FIGS. **6**A-**6**D, 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 hydrocarbon 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**.

[0046] 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**.

[0047] 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**.

[0048] Referring first to FIG. **6**A, 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**.

[0049] Moving now to FIG. **6**B, tool **100** is lowered laterally offset from joint **200** and outside of plume **360** until lower end **110***b* 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**.

[0050] Next, referring to FIG. **3** and FIG. **6**C, 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.

[0051] 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 **110***b* 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.

[0052] 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 **167***a* 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 **160***b*. 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 **135***b*, **164***b* 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 **168***c* are flexed radially outward and/or basket grapple **160** is radially expanded via circumferential displacement of ends **160***c, d*. Since basket grapple **160** is biased to the unexpanded position, internal threads **167** and associated teeth **167***a* are urged radially inward into engagement with flange **201** as flange **201** is seated in basket grapple **160**.

[0053] Referring now to FIGS. **6**C, **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 **135***a*, **164***a* come into contact. The continued application of axial lifting forces to housing **110** causes surfaces **135***a* to cam fingers **168***c* radially inward, thereby causing teeth **167***a* "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. **6**D. 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.

[0054] 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**.

[0055] Referring now to FIGS. **1**, **2** and **6**C, 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 **167***a* engaging flange **201** are defined by internal threads **167**. Thus, rotation of housing **110** and basket grapple **160** relative to flange **201** enables teeth **167***a* 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.

[0056] Referring now to FIGS. **1** and **6**D, 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 unthread 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 **135***b*, **164***b* move together and surfaces **135***a*, **164***a* move apart, thereby removing the camming forces applied to fingers **168***c* by surfaces **135***a* and creating radial clearance between surfaces **135***a*, **164***b*. Since basket grapple **160** is secured to upper flange **201** via engagement of teeth **167***a* 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 **160***c, 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 **167***a* 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 **167***a* 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 **167***a* 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 **160***c, 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 **160***a* 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 **167***a* 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 **6**D, 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 **168***c* radially inward, thereby causing teeth **167** to bite into flange **201**. In general, the camming force applied to fingers **168***c* 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 a 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.

* * * * *