

ELEMENT PRESSURE RELEASE SYSTEM

BACKGROUND

1. Field

5 [0001] The present disclosure relates generally to packer assemblies usable in a bore in a subterranean formation and more particularly to element pressure release systems capable of withstanding relatively large load forces that are retrievable from the bore.

2. Description of Related Art

10 [0002] Wells are drilled at various depths to access and produce oil, gas, minerals, and other naturally-occurring deposits from subterranean geological formations. Hydrocarbons may be produced through a wellbore traversing the subterranean formations. During completion of a well, packer assemblies can be used in the wellbore to separate the wellbore into one or more zones. A packer assembly is typically used to provide a seal between the outside of a production tubing string and the inside of a casing, liner, or wellbore wall. The seal may be provided by a packer element, and a slip is
15 responsible for retaining the packer assembly in position by gripping the casing string or other outer conduit or surface against which the packer is intended to seal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The following figures are included to illustrate certain aspects of the present disclosure, and should not be viewed as exclusive embodiments. The subject matter disclosed is capable of considerable modifications, alterations, combinations, and equivalents in form and function, without departing from the scope of this disclosure.

[0004] FIG. 1 illustrates a schematic view of a well in which an illustrative embodiment of an element pressure release system is deployed;

[0005] FIG. 2 illustrates a cross sectional view of an illustrative embodiment of a packer assembly of FIG. 1;

[0006] FIG. 3A illustrates a partial cutaway view of an illustrative embodiment of an element pressure release system in a coupled/latched position;

[0007] FIG. 3B illustrates a partial cutaway view of an illustrative embodiment of an element pressure release system in a decoupled/released position; and

[0008] FIG. 3C illustrates an enlarged view of teeth from a wedge and locking lug of the element pressure release system of FIG. 3A.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0009] In the following detailed description of the illustrative embodiments, reference is made to the accompanying drawings that form a part hereof. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is understood that other embodiments may be utilized and that logical structural, mechanical, electrical, and chemical changes may be made without departing from the spirit or scope of the invention. To avoid detail not necessary to enable those skilled in the art to practice the embodiments described herein, the description may omit certain information known to those skilled in the art. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the illustrative embodiments is defined only by the appended claims.

[0010] Unless otherwise specified, any use of any form of the terms "connect," "engage," "couple," "attach," or any other term describing an interaction between elements is not meant to limit the interaction to direct interaction between the elements and may also include indirect interaction between the elements described. 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". Unless otherwise indicated, as used throughout this document, "or" does not require mutual exclusivity.

[0011] As used herein, the phrases "hydraulically coupled," "hydraulically connected," "in hydraulic communication," "fluidly coupled," "fluidly connected," and "in fluid communication" refer to a form of coupling, connection, or communication related to fluids, and the corresponding flows or pressures associated with these fluids. In some embodiments, a hydraulic coupling, connection, or communication between two components describes components that are associated in such a way that fluid pressure may be transmitted between or among the components. Reference to a fluid coupling, connection, or communication between two components describes components that are associated in such a way that a fluid can flow between or among the components. Hydraulically coupled, connected, or communicating components may include certain arrangements where fluid does not flow between the components, but fluid pressure may nonetheless be transmitted such as via a diaphragm or piston.

[0012] The present disclosure relates generally to an element pressure release system that allows retrieval of packer assemblies set in a wellbore. When installed with

slips, packer assemblies are typically considered permanent installations, and removal of these assemblies from the well may require milling and other costly operations. The embodiments described herein allow release of a standard slip used to retain the packer in a set or permanent position. By moving a mandrel upon which the packer assembly is delivered downhole, the forces exerted against the slip are released, thereby allowing the packer assembly to be retrieved from the wellbore.

[0013] Referring now to FIG. 1, an element pressure release system 100 according to an illustrative embodiment is used in a well 102 having a wellbore 104 that extends from a surface 108 of the well to or through a subterranean geological formation 112. The well 102 is illustrated onshore in FIG. 1, but the well could alternatively be an offshore well accessed by a floating or fixed platform. The element pressure release system 100 is part of a packer assembly 114 that has been positioned in the well during or after production tubing 116 is run into the well 102. The packer assembly 114 may be deployed and set by conventional or other unconventional methods.

[0014] Referring now to FIGS 2 – 3C, a packer assembly 201 includes an element pressure release system 202 that provides a simplified mechanism for releasing compression (or element pressure) that is stored within a permanent packer, or a packer that employs a pair of opposing casing slips used to retain the packer in the set position. The system may provide a less complicated and more cost effective means of retrieving an otherwise permanently-set packer.

[0015] Referring more specifically to FIG. 2, the packer assembly 201 may include a mandrel 203 that is connected to or received on a production tubing string extending from the surface of the well. As is typical of most opposing slip packer assemblies, the mandrel 203 may support an upper casing slip 205 and a lower casing slip 207. Each casing slip 205, 207 may be adjacent a wedge 209, 211 that is slidably received on the mandrel 203. The wedges 209, 211 are capable of sliding between the casing slips 205, 207 and the mandrel 203 as the packer assembly 201 is activated or "set" downhole. The wedges 209, 211 may each include a ramped portion 213, 215 with ramped surface 212, 214. As the packer assembly is set, the ramped surfaces 212, 214 of the wedges 209, 211 each engage a complimentary ramped surface 216, 218 associated with the casing slips 205, 207. Movement of each wedge 209, 211 toward its respective casing slip 205, 207 results in each casing slip 205, 207 being pushed radially outward such that teeth 217, 219 on the casing slips 205, 207 may engage an inner surface of the casing, or alternatively a liner or an uncased wellbore wall. As the packer assembly 201 is set,

compression or other forces are also exerted on an expandable element 221 to provide sealing against the casing, liner, or wellbore wall as the element 221 expands into contact with the casing, liner, or wellbore wall. This compressive force within the packer assembly 201 is retained by the upper and lower casing slips 205, 207, which prevent the compressive force within the packer assembly 201 from releasing.

[0016] Referring still to FIG. 2, but also to FIGS. 3A and 3B, the element pressure release system 202 may be provided to allow a user to release the compressive force stored within the packer assembly 201 so that the packer assembly 201 may be retrieved from the wellbore. The element pressure release system 202 may include a recess or a groove 303 disposed in the mandrel 203 and one or more lugs, or locking lugs 305. Each locking lug 305 may include one or more grooves or teeth 307 that engage complimentary one or more grooves or teeth 309 on the wedge 209 when the element pressure release system 202 (and packer assembly 201) is in a coupled or set position as illustrated in FIG. 3A. In this set position, the locking lug 305 is positioned on an outer surface of the mandrel 203 as illustrated in FIG. 3A, and the teeth 307 of the locking lug 305 and the wedge 209 are engaged such that forces may be transmitted between the wedge 209 and the locking lug 305. The locking lug 305 fits within a window 311 of a retainer 313 that is slidably received on the mandrel 203. The retainer 313 abuts the expandable element 221 and is capable of transferring forces to the locking lug 305. Again, these forces, when the packer is set in place downhole, are generally compressive in nature and tend to compress the element 221 into an expanded (and sealing) position and also drive the casing slips 205, 207 radially outward to bite into the inner diameter of the casing.

[0017] In some embodiments, the window 311 of the retainer 313 passes through the retainer, and the retainer 313 may extend around a perimeter of the window 311. In some embodiments, the retainer 313 may surround the perimeter of the window 311. The presence of the window and the ability to cradle or surround the locking lug 305 is advantageous. The window 311 assists in containing the locking lug 305.

[0018] A face 315 of the window that engages a face 316 of the locking lug is used for bearing, and the geometry of the window and lug, or their respective faces 315, 316, could be adjusted to control load, tilt (negative or positive), or other parameters. For example, the faces 315, 316 may be substantially perpendicular to adjacent surfaces of the retainer 313 or locking lug 305 as illustrated in FIGS. 3A and 3B, or alternatively, non-perpendicular faces 315, 316 (relative to adjacent surfaces) may be provided depending on the desired load profile between the retainer 313 and locking lug 305.

[0019] The geometry or shape of the window 311 and the locking lug 305 contained within the window 311 may also vary. Although the window 311 illustrated in FIGS. 3A and 3B appears to be C-shaped with an open side, the window 311 is only partially displayed for purposes of adequately displaying the locking lug 305. In this embodiment, the window 311 may be rectangular in shape to constrain a rectangular-shaped locking lug 305. In some embodiments, the window 311 may instead be circular, triangular, oval, or may include other shapes as long as the locking lug 305 within the window is adequately able to facilitate transfer of force between the retainer 313 and the wedge 209.

[0020] FIGS. 3A and 3B illustrate a cross-sectional view of the element pressure release system 202, and only a single window 311 (or portion of a window) and locking lug 305 is illustrated. While in some embodiments, only a single window 311 and locking lug 305 may be associated with each retainer 313, in other embodiments multiple windows 311 and locking lugs 305 may be employed. For example, in one embodiment, each retainer 313 may include a pair of windows 311 disposed on opposing sides of the retainer 313. In other embodiments, more than two windows 311 and locking lugs 305 may be employed and may be spaced circumferentially around the retainer 313 with equal or unequal spacing. For example, in some embodiments, eight windows 311 may be circumferentially spaced around the retainer 313.

[0021] The depth and other size parameters of the groove 303 of the mandrel 203 are such that the groove 303 is able to receive the locking lug 305 when the mandrel 203 is moved axially to place the element pressure release system 202 in the decoupled or release position illustrated in FIG. 3B. In this release position, the locking lug 305 is able to drop into the groove 303 a distance sufficient to allow the one or more grooves or teeth 307 of the locking lug 305 to disengage the one or more grooves or teeth 309 of the wedge 209. When the locking lug 305 and wedge 209 disengage, the stored forces within the packer assembly 201 are released, which results in a contraction of the expandable element 221. The release also relieves the forces exerted by the wedge 209 on the casing slips 205, 207, which allows the casing slips 205, 207 to disengage themselves from the casing, or alternatively a liner, or an uncased wellbore wall. This disengagement of the casing slips 205, 207 permits subsequent retrieval of the packer assembly 201.

[0022] Referring to FIG. 3C, an enlarged view of teeth (or grooves) 309, 307 from wedge 209 and locking lug 305 of the element pressure release system 202 of FIG. 3A is illustrated. While the shape of the teeth 309, 307 may vary in different embodiments, an

angle α of the teeth may in one embodiment be approximately sixty degrees. In other embodiments, the angle α may be greater than or less than sixty (60) degrees, but it is desired that the angle α not become too small such that it becomes difficult for the wedge 209 and the locking lug 305 to disengage when the packer assembly 201 is moved to the release position. In other words, it is desired that the angle α be large enough that locking lug 305 disengages from the wedge 209 when the mandrel 203 is moved to position the recess or groove 303 beneath the locking lug 305. In some embodiments, if the angle α is twenty-nine (29) degrees or less, the locking lug 305 is not easily disengaged from the wedge 209.

[0023] It is believed that the presence of windows 311 in the retainer 311, and one or more locking lugs 305 within each window 311 provides better containment and control over the locking (or “set”) and release capabilities of the element pressure release system 202. The independent locking lugs 305 are able to move freely relative to one another and do not suffer the same geometrical constraints as other components, such as a C-ring. If used in place of a plurality of lugs, the C-ring may provide less reliability in locking and releasing since the C-ring is circular in either its expanded or collapsed positions and elliptical in the other position.

[0024] It is important for well operators to be able to easily and cost effectively retrieve packers from a wellbore. The present disclosure describes systems, assemblies, and methods for setting and retrieving a packer assembly that includes opposed casing slips. In addition to the embodiments described above, many examples of specific combinations are within the scope of the disclosure, some of which are detailed below.

[0025] Example 1. An element pressure release system comprising:

- a mandrel having at least one groove or recess;
 - a retainer having at least one window passing through the retainer, the retainer extending around a perimeter of the at least one window;
 - a lug positioned in the at least one window of the retainer; and
 - a wedge configured to engage a casing slip and the lug such that, when the element pressure release system is in a coupled position, the lug is capable of transferring a force from the retainer to the wedge and the casing slip;
- wherein the element pressure release system is positionable in a decoupled position in which the mandrel is moved to align the at least one groove or recess with the lug to allow the lug to become

disengaged from the wedge and thereby no longer transfer the force from the retainer to the wedge.

[0026] Example 2. The element pressure release system of example 1, wherein the wedge comprises one or more teeth or grooves to engage the lug.

5 [0027] Example 3. The element pressure release system of example 2, wherein the lug comprises complimentary one or more teeth or grooves to engage the one or more teeth or grooves of the wedge.

[0028] Example 4. The element pressure release system of any of examples 1-3, wherein the element pressure release system in the decoupled position allows
10 disengagement of the casing slip and retrieval of the element pressure release system from a bore.

[0029] Example 5. The element pressure release system of any of examples 1-4, wherein, when the element pressure release system is in the coupled position:

the lug is constrained between the wedge and the mandrel; and

15 the lug is surrounded on any remaining sides by the retainer.

[0030] Example 6. The element pressure release system of any of examples 1-5, wherein, when the element pressure release system is in the decoupled position:

the lug is received by the groove or recess of the mandrel and is spaced apart from the wedge; and

20 the lug is surrounded on any remaining sides by the retainer.

[0031] Example 7. The element pressure release system of any of examples 1-6, wherein the at least one window comprises eight windows circumferentially spaced around the retainer.

[0032] Example 8. The element pressure release system of example 7, wherein the
25 lug in each of the windows is independently capable of moving into the groove or recess relative to the other lugs.

[0033] Example 9. The element pressure release system of any of examples 1-8, wherein the retainer extending around a perimeter of the at least one window further comprises the retainer surrounding the perimeter.

30 [0034] Example 10. The element pressure release system of any of examples 1-9, wherein the at least one window further comprises:

a plurality of windows, each window being independent from other windows and each window being surrounded along the perimeter by the retainer;

wherein the lug in each of the windows is independently capable of moving into the groove or recess relative to the other lugs; wherein, when the element pressure release system is in the coupled position, the lug is constrained between the wedge and the mandrel; wherein, when the element pressure release system is in the decoupled position, the lug is received by the groove or recess of the mandrel and is spaced apart from the wedge; and wherein, when the element pressure release system is in either the coupled position or the decoupled position, each of the lugs remain within the windows.

[0035] Example 11. A method comprising:

running an element pressure release system into a bore of a subterranean formation, the element pressure release system comprising:

a wedge;

a mandrel comprising at least one groove or recess; and

one or more lugs in a window of a retainer, wherein the one or more lugs are located at least partially between the wedge and the mandrel;

moving the mandrel to a release position where the at least one groove or recess in the mandrel receives the one or more lugs, wherein the wedge responds to the movement of the one or more lugs to release a force applied by the wedge to a slip.

[0036] Example 12. The method of example 11, wherein:

the wedge comprises one or more teeth or grooves to engage the one or more lugs; and

the one or more lugs comprise one or more complimentary teeth or grooves to engage the one or more teeth or grooves of the wedge.

[0037] Example 13. The method of example 11 or 12, further comprising removing the element pressure release assembly from the bore.

[0038] Example 14. The method of any of examples 11-13, wherein the retainer, when the one or more lugs is positioned in the window of the retainer, surrounds a perimeter of the one or more lugs.

[0039] Example 15. A packer assembly capable of being disposed in a bore in a subterranean formation, the packer assembly comprising:

a slip; and
a wedge capable of, in a set position of the packer assembly, exerting a
force on the slip to cause the slip to engage a casing or other surface,
the wedge being capable of, in a release position of the packer
assembly, allowing the slip to disengage the casing or other surface;
wherein the wedge is held in the set position by a lug positioned within a
window of a retainer.

[0040] Example 16. The packer assembly of example 15, wherein the packer
assembly is retrievable from the bore subsequent to the packer assembly being positioned
in the release position.

[0041] Example 17. The packer assembly of example 15 or 16, wherein the lug is
constrained by the window of the retainer in both the set position and the release position.

[0042] Example 18. The packer assembly of any of examples 15-17, further
comprising a mandrel comprising a groove or recess capable of receiving the lug in the
release position, wherein the lug, when received by the groove or recess, releases the
wedge.

[0043] Example 19. The packer assembly of any of examples 15-18, wherein:
the wedge comprises one or more teeth or grooves to engage the lug; and
the lug comprises one or more complimentary teeth or grooves.

[0044] Example 20. The method of any of examples 15-19, wherein the retainer,
when the lug is positioned in the window of the retainer, surrounds a perimeter of the lug.

[0045] Example 21. An element pressure release system as shown and described
herein.

[0046] Example 22. A method of setting or releasing a packer or element pressure
release system as shown and described herein.

[0047] It should be apparent from the foregoing that embodiments of an invention
having significant advantages have been provided. While the embodiments are shown in
only a few forms, the embodiments are not limited but are susceptible to various changes
and modifications without departing from the spirit thereof.

CLAIMS

1. An element pressure release system comprising:
 - a mandrel having at least one groove or recess;
 - a retainer having at least one window passing through the retainer, the retainer extending around a perimeter of the at least one window;
 - a lug positioned in the at least one window of the retainer; and
 - a wedge configured to engage a casing slip and the lug such that, when the element pressure release system is in a coupled position, the lug is capable of transferring a force from the retainer to the wedge and the casing slip;
 - wherein the element pressure release system is positionable in a decoupled position in which the mandrel is moved to align the at least one groove or recess with the lug to allow the lug to become disengaged from the wedge and thereby no longer transfer the force from the retainer to the wedge;
 - wherein the lug and the wedge comprise one or more grooves or teeth that engage complementarily with each other to transfer the force between the lug and the wedge when the element pressure release system is in a coupled position;
 - wherein the window and the lug further comprise respective faces that engage with each other;
 - wherein the face of the window that engages with the face of the lug is used for bearing; and
 - wherein the geometry of the window and the lug or their respective faces could be adjusted to control load.
2. The element pressure release system of Claim 1, wherein the faces of the window or the lug may be tilted either positively or negatively to control load.
3. The element pressure release system of Claim 1, wherein the faces of the window or the lug may be perpendicular or non-perpendicular relative to adjacent surfaces of the retainer or the lug depending on desired load profile between the retainer and the lug.
4. The element pressure release system of Claim 1, wherein the angle of the one or more grooves or teeth of the lug or the wedge is sixty (60) degrees or greater in order that the lug disengages easily from the wedge when the mandrel is moved to position the at least one groove or recess thereof beneath the lug.

5. The element pressure release system of Claim 1, wherein the angle of the one or more grooves or teeth of the lug or the wedge is greater than twenty-nine (29) degrees but less than sixty (60) degrees.
6. The element pressure release system of Claim 1, wherein the element pressure release system in the decoupled position allows disengagement of the casing slip and retrieval of the element pressure release system from a bore.
7. The element pressure release system of Claim 1, wherein, when the element pressure release system is in the coupled position:
 - the lug is constrained between the wedge and the mandrel; and
 - the lug is surrounded on any remaining sides by the retainer.
8. The element pressure release system of Claim 1, wherein, when the element pressure release system is in the decoupled position:
 - the lug is received by the groove or recess of the mandrel and is spaced apart from the wedge; and
 - the lug is surrounded on any remaining sides by the retainer.
9. The element pressure release system of Claim 1, wherein the at least one window comprises eight windows circumferentially spaced around the retainer.
10. The element pressure release system of Claim 9, wherein the lug in each of the windows is independently capable of moving into the groove or recess relative to the other lugs.
11. The element pressure release system of Claim 1, wherein the retainer extending around a perimeter of the at least one window further comprises the retainer surrounding the perimeter.
12. The element pressure release system of Claim 1, wherein the at least one window further comprises:
 - a plurality of windows, each window being independent from other windows and each window being surrounded along the perimeter by the retainer; wherein the lug in each of the windows is independently capable of moving into the groove or recess relative to the other lugs;

wherein, when the element pressure release system is in the coupled position, the lug is constrained between the wedge and the mandrel;

wherein, when the element pressure release system is in the decoupled position, the lug is received by the groove or recess of the mandrel and is spaced apart from the wedge; and

wherein, when the element pressure release system is in either the coupled position or the decoupled position, each of the lugs remain within the windows.

13. A method, comprising:

running an element pressure release system into a bore of a subterranean formation, the element pressure release system comprising:

a wedge;

a mandrel comprising at least one groove or recess; and

one or more lugs in a window of a retainer, wherein the one or more lugs are located at least partially between the wedge and the mandrel; and

moving the mandrel to a release position where the at least one groove or recess in the mandrel receives the one or more lugs, wherein the wedge responds to the movement of the one or more lugs to release a force applied by the wedge to a slip;

wherein the wedge comprises one or more grooves or teeth to engage the one or more lugs;

wherein the one or more lugs comprise one or more complimentary grooves or teeth to engage the one or more grooves or teeth of the wedge;

wherein the window and the lug further comprise respective faces that engage with each other;

wherein the face of the window that engages with the face of the lug is used for bearing; and

wherein the geometry of the window and the lug or their respective faces could also be adjusted to control load.

14. The method of Claim 13, wherein the faces of the window or the lug may be tilted either positively or negatively to control load.

15. The method of Claim 13, wherein the faces of the window or the lug may be perpendicular or non-perpendicular relative to adjacent surfaces of the retainer or the lug depending on desired load profile between the retainer and the lug.

16. The method of Claim 13, wherein:

the wedge comprises one or more teeth or grooves to engage the one or more lugs;
and

the one or more lugs comprise one or more complimentary teeth or grooves to engage the one or more teeth or grooves of the wedge.

17. The method of Claim 13, wherein the angle of the one or more grooves or teeth of the lug or the wedge is sixty (60) degrees or greater in order that the lug disengages easily from the wedge when the mandrel is moved to position the at least one groove or recess thereof beneath the lug.

18. The method of Claim 13, further comprising removing the element pressure release assembly from the bore.

19. The method of Claim 13, wherein the retainer, when the one or more lugs are positioned in the window of the retainer, surrounds a perimeter of the one or more lugs.

20. A packer assembly capable of being disposed in a bore in a subterranean formation, the packer assembly comprising:

a slip;

a mandrel supporting the slip; and

a wedge, slidably received on the mandrel and adjacent to the slip, capable of, in a set position of the packer assembly, exerting a force on the slip to cause the slip to engage a casing or other surface, the wedge being capable of, in a release position of the packer assembly, allowing the slip to disengage the casing or other surface;

wherein the wedge is held in the set position by a lug positioned within a window of a retainer;

wherein the lug and the wedge comprise one or more grooves or teeth that engage complementarily with each other when the packer assembly is in the set position;

wherein the window and the lug further comprise respective faces that engage with each other;

wherein the face of the window that engages with the face of the lug is used for bearing; and

wherein the geometry of the window and the lug or their respective faces could also be adjusted to control load.

21. The packer assembly of Claim 20, wherein the faces of the window or the lug may be tilted either positively or negatively to control load.

22. The packer assembly of Claim 20, wherein the faces of the window or the lug may be perpendicular or non-perpendicular relative to adjacent surfaces of the retainer or the lug depending on desired load profile between the retainer and the lug.
23. The packer assembly of Claim 20, wherein the angle of the one or more grooves or teeth of the lug or the wedge is sixty (60) degrees or greater in order that the lug disengages easily from the wedge when the mandrel is moved to position the at least one groove or recess thereof beneath the lug.
24. The packer assembly of Claim 20, wherein the angle of the one or more grooves or teeth of the lug or the wedge is greater than twenty-nine (29) degrees but less than sixty (60) degrees.
25. The packer assembly of Claim 20, wherein the packer assembly is retrievable from the bore subsequent to the packer assembly being positioned in the release position.
26. The packer assembly of Claim 20, wherein the lug is constrained by the window of the retainer in both the set position and the release position.
27. The packer assembly of Claim 20, further comprising a mandrel comprising a groove or recess capable of receiving the lug in the release position, wherein the lug, when received by the groove or recess, releases the wedge.
28. The packer assembly of Claim 20, wherein the retainer, when the lug is positioned in the window of the retainer, surrounds a perimeter of the lug.