A retrievable compression set packer is sequentially released. First the sealing element is allowed to relax. Then the upper slip has wedging action that forces it against a surrounding tubular relaxed. After that the upper slips are pulled up to retract them fully allowing the packer to come out. These sequential actions are done with a mandrel movement in one direction. The sealing element is released with undermining a collet by aligning collet heads with a recess on the mandrel. The slip force release happens with mandrel movement forcing a ring into a wedge such that circumferential force on slip segments is reduced or eliminated when the wedge is pushed out of its conforming slot allowing for circumferential flexibility of the slip seat. The mandrel then picks up a slip ring that retracts the slip segments on the slip seat and the packer is removed.
SEQUENTIAL PACKER SEALING ELEMENT AND SLIP RELEASE MECHANISM

FIELD OF THE INVENTION

The field of the invention is compression set packers and more particularly a release mechanism that sequentially releases the packer seal and then the slips before packer retrieval.

BACKGROUND OF THE INVENTION

Retrievable compression set packers typically have a pair of opposed slips straddling a sealing element. A setting piston creates relative movement that sets the packer. The relative movement pushes an upper slip out on a ramp to anchor the mandrel. Further pushing compresses the sealing element to contact the surrounding tubular followed by pushing the lower slips outward into engagement with the surrounding tubular. When all that is done a locking mechanism locks in the relative movement that set the packer slips and seal.

When it is time to retrieve the packer some designs have defeated a lock located below a lower slip to allow the packer seal to extend. This design is shown in U.S. Pat. No. 5,273,109; U.S. Pat. No. 5,727,632; U.S. Pat. No. 8,550,177 and U.S. Pat. No. 8,291,989. Slip release mechanisms for tapered slips surrounded on opposed sides by slanted tapers have been used and released with pulling out a tapered wedge from a slot in a ring that holds the slip segments to allow a slip ring with T-shaped cutouts to literally pull the slip segments up to retract them. This is shown in U.S. Pat. No. 5,487,427.

What is needed and provided by the present invention is a coordinated release of the rubber pressure in the seal followed by a reduction or elimination of the setting force into the slip segments so that the upper slips could then be picked up as a third movement for retrieval of the packer from the borehole. These and other aspects of the present invention will be more readily apparent to those skilled in the art from a review of the detailed description of the preferred embodiment and the associated drawings while recognizing that the full scope of the invention is to be determined by the appended claims.

SUMMARY OF THE INVENTION

A retrievable compression set packer is sequentially released. First the sealing element is allowed to relax. Then the upper slip has wedging action that forces it against a surrounding tubular relaxed. After that the upper slips are pulled up to retract them fully allowing the packer to come out. These sequential actions are done with a mandrel movement in one direction. The sealing element is released with undermining a collet by aligning collet heads with a recess on the mandrel. The slip force release happens with mandrel movement forcing a ring into a wedge such that circumferential force on slip segments is reduced or eliminated when the wedge is pushed out of its forming slot allowing for circumferential flexibility of the slip seat. The mandrel then picks up a slip ring that retracts the slip segments on the seat and the packer is removed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a is a section view of the retrievable packer when running in;

FIG. 1b is the view of FIG. 1a with the sealing element and upper slips released for retrieval;
FIG. 2a is an enlarged view of a part of FIG. 1a;
FIG. 2b is an enlarged view of a part of FIG. 1b;
FIG. 3a is an exterior plan view of a part of the packer shown in FIG. 1a;
FIG. 3b is an exterior plan view of a part of the packer shown in FIG. 1b;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1a shows a mandrel 10 having a passage 12 therethrough. An outer assembly 14 starts with a slip ring 16 at the downhole end followed by lower slips 18 that ride on a ramped slip seat 20. Adjacent the slip seat 20 is an anti-extrusion ring 22 and a seal assembly generally referred to as 24. Another anti-extrusion ring 26 is held in place with telescoping sleeve 28 secured against telescoping to a shorter axial dimension by collet 40 extending from a collet ring 30. Upper sleeve 32 retains upper slip seat 34 that interacts with the upper slips 36 that are interconnected by slip ring 38. Collet ring 30 has a series of collet heads 40 secured to sleeve 28 with meshing tooth profiles 42. Heads 40 are supported off mandrel 10 for running in. Recess 44 is offset from heads 40 when running in but when the release process is started and mandrel 10 is picked up the first thing that happens is that recess 44 aligns with heads 40. The retained rubber pressure in the seal 24 can push sleeve 28 to the point that surface 46 hits surface 48 on collet ring 30. The seal assembly can then relax and stretch to the position shown in FIG. 1b where a part of the assembly with extrusion ring 26 is pulled away from the balance of the seal assembly 24 to allow reduction of diameter that it will take to allow removal of the packer.

Further axial movement of the mandrel 10 takes ring 50 supported by mandrel 10 against ring 52 for tandem movement thereafter. As better seen in FIGS. 2a and 2b ring 52 engages wedge 54 as better seen in FIG. 3b. Movement of wedge 54 takes its taper 56 out of conforming space 58 in several circumferentially spaced locations. This allows relaxation or elimination of circumferential compressive force on opposed sides of each segment to relax such that further movement of mandrel 10 then engages the slip ring 38 that has a plurality of spaced T-shaped members 56 that engage grooves 59 in the slip segments 36 to pull up the slip segments 36 along opposing surfaces 60 and 62 which retracts the segments 36 and holds them retracted as the packer is retrieved.

Those skilled in the art will appreciate that in a continuous movement of the mandrel 10 the seal assembly is allowed to relax and extend first. Further mandrel movement in the same direction then moves wedge 56 out of conforming shape 58 in the upper slip seat 34 to release circumferential compression forces on the segments 36 so that further mandrel movement can engage the slip ring 38 to retract the segments the rest of the way so that the packer can be retrieved. This sequential release of packer components enhances the odds of a packer removal without incident such as getting stuck or some of the gripping components failing to release, either of which can require an excessive milling out. While collets are released to allow the seal assembly to extend axially and retract radially other locking devices can be used such as dogs or shearable members to allow the sealing element to axially extend and
radially retract. The configuration of the seal assembly and slips can be altered as long as the slip design is amenable to a release of most if not all the force holding the slips to the surrounding tubular when the mandrel is moved. The preferred design allows mandrel movement to reduce holding force before there is axial slip movement.

[0015] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below:

We claim:

1. A retrievable packer for subterranean use against a borehole wall, comprising:
an outer assembly comprising at least one slip and a sealing element mounted to a relatively movable mandrel;
said outer assembly compressible for radial extension of said at least one slip and said sealing element against the borehole wall for pressure isolation, defining a set position of said outer assembly;
said outer assembly retractable toward a retrieve position away from the borehole wall with relative movement of said mandrel to sequentially relieve pressure in said sealing element and then reduce gripping force on said at least one slip.

2. The retrievable packer of claim 1, wherein:
movement of said mandrel allows said sealing element to extend axially.

3. The retrievable packer of claim 2, wherein:
movement of said mandrel unlocks a locking mechanism to allow said sealing element to extend axially.

4. The retrievable packer of claim 3, wherein:
said outer assembly comprising a telescoping sleeve held in an initial position by said locking mechanism with support from said mandrel.

5. The retrievable packer of claim 4, wherein:
movement of said mandrel removes support for said locking mechanism allowing said telescoping sleeve to shorten and said sealing element to axially extend toward said retrieve position.

6. The retrievable packer of claim 5, wherein:
said locking mechanism comprises at least one collet or dog that prevents telescoping of said sleeve when supported by said mandrel until a recess in said mandrel opposes said collet or dog to allow radial movement releasing said sleeve to telescope to a shorter dimension.

7. The retrievable packer of claim 1, wherein:
movement of said mandrel reduces circumferential force acting on said at least one slip by a slip seat.

8. The retrievable packer of claim 7, wherein:
said slip seat comprising spaced extending members flanking said at least one slip and having an elongated slot initially filled with a movable member having a conforming shape to said elongated slot to support delivery of a circumferential force to said at least one slip in said set position from said flanking extending members.

9. The retrievable packer of claim 8, wherein:
said movable member and said slot having conforming tapers such that axial movement of said movable member creates gaps in said slot to allow said extending members to flex and reduce circumferential force on said at least one slip toward said set position.

10. The retrievable packer of claim 9, wherein:
movement of said mandrel moves said movable member after earlier movement has relieved pressure in said sealing element.

11. The retrievable packer of claim 10, wherein:
further mandrel movement after moving said movable member engages said mandrel to a slip ring for tandem movement to pull said at least one slip axially with respect to said spaced extending members which moves said at least one slip toward said mandrel.

12. The retrievable packer of claim 11, wherein:
said at least one slip comprises a plurality of circumferentially spaced slips each mounted between opposed extending members that define a conforming slip slot in said slip seat to form a ring structure with said spaced extending members of said slip seat and said slips.

13. The retrievable packer of claim 6, wherein:
movement of said mandrel reduces circumferential force acting on said at least one slip by a slip seat.

14. The retrievable packer of claim 13, wherein:
said slip seat comprising spaced extending members flanking said at least one slip and having an elongated slot initially filled with a movable member having a conforming shape to said elongated slot to support delivery of a circumferential force to said at least one slip in said set position from said flanking extending members.

15. The retrievable packer of claim 14, wherein:
said movable member and said slot having conforming tapers such that axial movement of said movable member creates gaps in said slot to allow said extending members to flex and reduce circumferential force on said at least one slip toward said set position.

16. The retrievable packer of claim 15, wherein:
movement of said mandrel moves said movable member after earlier movement has relieved pressure in said sealing element.

17. The retrievable packer of claim 16, wherein:
further mandrel movement after moving said movable member engages said mandrel to a slip ring for tandem movement to pull said at least one slip axially with respect to said spaced extending members which moves said at least one slip toward said mandrel.

18. The retrievable packer of claim 17, wherein:
said at least one slip comprises a plurality of circumferentially spaced slips each mounted between opposed extending members that define a conforming slip slot in said slip seat to form a ring structure with said spaced extending members of said slip seat and said slips.

* * * * *