FULL OPENING WELLHEAD WITH RETRACTILE SEAT

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ABSTRACT

A full opening, through bore, well casing head with a retractile split-ring seat that facilitates running maximum size downhole tools through the upper access opening of the casing head during drilling operations. The seat is inherently biased towards its contracted condition wherein it extends into the head's bore in functional position, and is retracted from the bore into an annular recess in the head by rotation of a cam element located between the opposed ends of the seat where it is split.

4 Claims, 9 Drawing Figures
FIG. 6

FIG. 7
FULL OPENING WELLHEAD WITH RETRACTILE SEAT

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to well apparatus, and more particularly to well casing heads with retractile seat mechanisms.

In oil or gas well drilling operations it is common, and sometimes even necessary, to develop the borehole in successively smaller diameter sections and line each section with casing. Usually a casing head is secured at ground level to the well's outermost or surface casing lining the first section of the borehole, and the successively smaller diameter strings of casing are then supported by hangers that rest on annular shoulders in the casing head bore. When the shoulders are cast or machined in the bore they are integral with the casing head, and since they cannot be retracted they limit the size of the well tools that can be passed through the head.

In the usual drilling procedure the first section of borehole is drilled and then lined with surface casing, a blowout preventer stack is mounted on the casing head, and drilling is then continued using bits of progressively lesser size as the hole expands. In many instances oversize bits are required to drill the hole to the desired size, and when the casing head and the annular shoulder or seat in its bore are integral there often is insufficient clearance for these bits.

Several techniques have been used to solve the problem, among them being the use of expandable bits that are passed through the casing head in contracted condition, and then expanded at the drilling level. However, the expandable bit often is undesirable because it frequently produces large cuttings which are difficult to remove from the hole, and if not removed these cuttings can clog the hole when the casing is cemented in place. Also, valuable time is required to expand and contract these bits, thereby increasing the expense of drilling the well.

Another solution to this problem involves starting with a larger casing head than ultimately required, thereby providing the needed clearance for the oversize bits, and then later changing to a smaller casing head and blowout preventer stack. This solution also has drawbacks, chiefly in the loss of valuable time that is required to accomplish the change of casing head and preventers.

A variety of casing heads have been devised with arquate segments that are extended inwardly from a retracted position in a recess in the casing head bore to present a plurality of seating surfaces resembling an annular shoulder. However, the hanger support surface presented by these devices is sometimes limited in size, and the segments themselves receive only limited support from the wall of the casing head. Furthermore, the segments in some of these heads have a tendency to jam in their retracted position from mud and cuttings that fill the recess in which they reside.

Some of the aforementioned casing heads have seat segments actuated by hydraulic or pneumatic pistons that occupy significant space around the head, and at least one head has a plurality of actuator screws around its periphery for moving the segments between their retracted and extended positions. Where several wellheads are tightly clustered in a small area such as on an offshore platform, access to each head can be so limited as to present a serious problem in positioning the actuator pistons, or in providing sufficient space around the head to operate each of the actuator screws.

SUMMARY OF THE INVENTION

The present invention overcomes the foregoing problems by providing a well casing head with a separate, retractile, split-ring seat element that is self-contracting into a functional position, and is retracted therefrom by a cam element operated from a single location outside the head. In its retracted position the seat ring is in expanded condition and resides in an annular groove or recess in the bore of the head, with its internal diameter at least as great as the bore's diameter so that it presents no obstruction to the passing of maximum size well tools through the head. In its extended position this seat ring is in contracted condition, extending into the head bore to provide an essentially full circle seating surface for firmly and properly supporting a casing hanger or other device in the head. The cam element is located between the opposed ends of the seat ring, i.e., within the split, and is shaped so that in one position it holds the seat ring expanded and in its other position the seat ring is contracted. The cam element is fixed to the inner end of a shaft that extends laterally through the wall of the head, and suitable means on the outer end of the shaft facilitates rotating it, and thus also the cam, about an arc of approximately 105° between the cam's two positions.

Accordingly, an object of the present invention is to provide a new and improved type of full opening, through bore well casing head apparatus.

Another object of the present invention is to provide a new type of retractile seat mechanism for a well casing head, which seat mechanism when retracted will provide a straight, unobstructed bore through the head to permit passage of maximum diameter well tools.

Yet another object of the present invention is to provide an improved seat mechanism for use in a wellhead that does not have to be changed during drilling and pipe hanging operations.

Still another object of the present invention is to provide an improved type of retractile well head seat mechanism that can be extended and retracted from a single location outside the head.

Further objects of the invention are to provide a retractile seat well head that can be installed and operated in very close proximity to other well heads; a seat mechanism that can be extended and retracted from outside the wellhead by simple tools from a single, readily accessible location; a retractile seat that can be expanded by well tools as they are pulled upward through it and then will return by itself to its contracted, functional position; and a retractile seat casing head assembly providing full annular support for the seat element directly on the casing head at all times.

The foregoing and other objects and advantages of the present invention will become apparent upon reference to the following description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view, partially broken away, of a retractile seat and full opening well casing head assembly according to the present invention, showing the seat in its extended, functional position.
FIG. 2 is a horizontal section of the casing head assembly of FIG. 1, taken along the line 2—2 of FIG. 1, and with parts removed.

FIG. 3 is an isometric view of the retractile seat of the casing head of FIG. 1.

FIG. 4 is a fragmentary view in vertical section of the casing head of FIG. 1, showing the position of the retractile seat in the head when in extended, functional, casing hanger-supporting position.

FIG. 5 is a view like FIG. 4, but showing the retractile seat in its retracted position.

FIG. 6 is a fragmentary isometric view of the casing head of this invention, showing the retractile seat in its contracted condition, and with parts broken away to better illustrate the cam mechanism for retracting the seat.

FIG. 7 is a fragmentary view in side elevation of the exterior components of the cam mechanism, taken in the direction of the arrow 7 in FIG. 6.

FIG. 8 is a view like FIG. 6, but with the seat in its expanded condition.

FIG. 9 is a view like FIG. 7, but taken in the direction of the arrow 9 in FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Broadly considered, the present invention comprises a full opening well casing head 10, a retractile split-ring type seat element 12, and a cam mechanism 14 mounted for rotation in the head 10 to expand the seat 12 from its extended, functional position in the casing head as illustrated in FIGS. 1—4, 6 and 7, into its retracted position as shown in FIGS. 5, 8 and 9.

The casing head 10, which is fixed to and supported by an outermost or surface casing 16 when properly installed at a well site, is comprised of lower or downhole section 18 and upper section 20, respectively, that are threaded together at 22. Bores 24, 26 through the sections 18, 20 are equal in diameter, so that when these sections are assembled into an unobstructed, straight-through bore 27 is formed in the casing head 10 through the upper access opening of section 20 and lower downhole section 18 communicating with surface casing 16.

The lower section 18 of the casing head 10 is counterbored at 28, and has a radial surface 30 extending between the bore 24 and this counterbore. The lower end of the casing head's upper section 20 has a radial surface 32 that extends inwardly from the external threads 34 to an annular, downward-extending axial surface 36 (FIGS. 4 and 5) of short dimension, and a conical surface 38 extends upwardly and inwardly from the axial surface 36 to the upper section's bore 26. Thus, when the upper and lower casing head sections are fully threaded together so that the upper section's end surface 32 rests on the upward facing radial surface 40 of the lower section 18, an annular groove-like recess 42 (FIGS. 4 and 5) for the seat element 12 is formed by the surfaces 30, 28, 32, 36 and 38.

As perhaps viewed best in FIGS. 2 and 3, the seat element 12 is of split-ring configuration and has opposed ends 44, 46 with inner portions beveled at 44a, 46a. The inner and outer annular surfaces 48, 50 of the seat 12 are cylindrical, with the outer surface 50 interrupted by a plurality of circumferentially spaced axial grooves 52 that have a depth of approximately one-half the radial thickness of the seat. These grooves 52 enhance the radial flexibility of the seat 12 without impairing the strength of the seat that is needed to adequately perform the function of a casing hanger support.

The bottom surface 54 of the seat 12 is planar, and rests securely on the radial, and also planar, surface 30 of the casing head's annular recess 42. As shown in FIG. 4, substantially all of the seat's bottom surface 54 is in contact with the recess surface 30 when the seat is extended in functional position into the casing head bore 27, thereby providing a bearing area adequate for transferring all loads that might be encountered to the casing head 10.

The top surface 56 of the split-ring type seat 12 has a radial, planar central portion 58, an inner, upwardly inclined conical portion 60, and an outer axial flange portion 62. The inner portion 60 of the seat's top surface functions as a support for a casing hanger, such as that represented by the element 64 in FIGS. 1 and 4, and because this annular surface 60 is broken only by the split in the seat it is essentially continuous and thus provides maximum bearing area for the hanger 64. This conical surface 60 also serves in self-centering the seat 12 when the hanger 64 is landed upon it. The axial flange 62 functions to retain the seat 12 in the recess 42 by cooperatively engaging the annular, axial surface 36 of the casing head's upper section 20, as can be seen in FIG. 4.

The lower end of the seat's inner surface 48 is beveled to provide a conical surface 66, and this surface functions as a cam to expand the seat upon application of an upward axial force against it. Accordingly, if the seat 12 should be extended into the casing head bore prematurely, well tools of maximum diameter can still be pulled up through the seat, causing it to expand and then contract as the tools pass through it.

The cam mechanism 14 for expanding the seat 12 into its retracted position in the recess 42, i.e. the position shown in FIGS. 5, 8 and 9, comprises a cam element 70 disposed between the opposed ends 44, 46 in the split in the seat 12, and a cylindrical cam shaft 72 fixed to the cam 70 and rotatably extending through a port 74 in the side wall of the casing head 10.

The cam shaft 72 has an inner radial flange 76 that is received in a counterbore 78 in the casing head's side wall, and an annular packing 80 in the counterbore 78 serves as an inner fluid seal for the shaft 72. The outer portion of the shaft 72 extends through an annular retainer element 82 that is secured to the outside of the casing head 10 by a plurality of cap screws 84, and this retainer 82 has a pair of arcuate lugs 86, 88 (FIGS. 2, 7 and 9) that extend axially beyond its outer annular end surface 90. The cam shaft 72 has a pair of intersecting, diametrical transverse bores 92, 94 axially located between the retainer surface 90 and the ends of the lugs 86, 88, the bore 92 serving to retain two cylindrical pins 96, 98 protruding radially from the cam shaft, and the bore 94 functioning to accept a cotter key 100.

The cam 70 is generally elongate in shape, having a longitudinal axis A (FIGS. 6 and 8) that is disposed vertically when the seat 12 is in its contracted, extended position (FIGS. 1, 2, 6 and 7), and disposed at an inclined position (FIGS. 8 and 9) approximately 105 degrees of rotation from the vertical when the seat 12 is fully retracted into the recess 42. The cam 70 has approximately contoured opposite side surfaces 106, 108 that bear against the seat's opposed ends 44, 46, re-
respectively as the cam is rotated to expand the seat, and flat opposite end surfaces 110, 112 that bear against these seat ends 44, 46 respectively, while the cam is holding the seat expanded.

Rotation of the cam 70 is facilitated by a wrench or other manual tool in cooperation with a square or other suitably shaped outer end 114 of the cam shaft 72. The lugs 86, 88 are dimensioned so that their faces 116, 118 constitute stops that cooperate with the cam shaft pins 96, 98 to halt further rotation of the shaft and cam clockwise, as viewed from outside the casing head 10 and properly position the cam so that the seat 12 is fully expanded. Similarly, faces 120, 122 of the lugs 86, 88 in cooperation with the pins 98, 96, respectively, preclude further counter-clockwise rotation of the cam 70 past its vertical position wherein the seat 12 is fully contracted into its functional, extended position (FIGS. 1, 2, 4, 6 and 7). As best seen in FIG. 9, the cam 70 can be releasably locked in its seat retracted position by installation of the cotter key 100 through the cam shaft's transverse bore 94, thereby preventing counterclockwise rotation of the cam until the cotter key is removed. Thus, the operator can be assured that the seat 12 is fully retracted into the recess 42 to provide a full open wellhead, and will remain in that position, when the cotter key is in place as indicated in FIG. 9.

As explained above, the annular packing 80 provides an internal seal between the cam shaft 72 and the lateral port 74 through the wall of the casing head 10, to preclude fluid leakage through the head in this area. An external annular camshaft packing 130 (FIGS. 1, 2, 6 and 8) also is provided in an external counterbore 132 in the outer surface of the head 12, this packing being held in place by the annular retainer 82. Accordingly, fluid-tight integrity between the cam shaft 72 and the casing head 10 is assured at both the internal and external ends of the port 74.

As should now be readily apparent, the above described invention provides a significant improvement in retractile seat, full opening wellheads, all in a device that is less complex, more compact, and considerably less time-consuming to operate, than any of the wellheads of the general type heretofore available. Structural strength of a very high order is provided by the unique seat element 12, and ease plus surety of expansion and contraction thereof are guaranteed by the cam mechanism 14. Thus, in all respects, each of the aforementioned objects and advantages of the present invention are achieved.

Although the best mode contemplated for carrying out the present invention has been herein shown and described, it will be apparent that modification and variation may be made without departing from what is regarded to be the subject matter of the invention.

I claim:

1. A well casing hanger apparatus for supporting a string of casing in an oil or gas well, said apparatus including a casing head having an upper end portion providing an access opening to a bore therethrough, a lower end portion having a downhole opening to said bore, and means disposed in said casing head between said access and downhole openings for providing a seat for a casing hanger introduced through said access opening to prevent its continued passage through said bore to said downhole opening, thereby to support a said casing hanger in said casing head, the improvement comprising:

said casing head bore being defined substantially by cylindrical walls thereof being full-opening and unobstructed therethrough to allow ready passage of well tools introduced through said access opening back and forth through said bore and said downhole opening,

an annular recess in said casing communicating with said bore intermediate said access and downhole openings,

a radially extending support surface at the downhole end of said recess, said surface facing said casing head access opening,

said casing hanger seat means comprising a normally contractile resilient split ring seated on said surface and having opposed ends defining said split,

said ring having a contracted inner diameter at the end thereof facing said casing head access opening less than the diameter of said bore and an outer diameter substantially greater than said bore thereby to support said ring on said recess surface when supporting a casing hanger in said casing head,

said ring end facing said access opening having a bore-obstructing abutment surface thereon configured to preclude radially outward camming forces thereon by a casing hanger introduced through said access opening thereby to abuttingly engage and support said casing hanger,

means for expanding said ring fully into said recess thereby to provide said ring when expanded with an inner diameter at least as great as the diameter of said bore, thereby to establish a full-open through bore in said head, said expanding means comprising a cam disposed between said ring ends and movable between a first position permitting contraction of said ring and a second position expanding said ring, and

means for moving said cam between said positions.

2. A well casing hanger apparatus according to claim 1, wherein said seat ring abutment surface is frustoconical, sloping downwardly and outwardly, for centering said ring in said casing head when a casing hanger having an upwardly and inwardly sloping frusto-conical surface thereon is landed thereupon, said ring surface providing a secure support for said casing hanger, said secure support thereby being non-releasable by radial expansion so long as said casing hanger rests on said frusto-conical surface.

3. A well casing hanger apparatus according to claim 1, wherein said seat element ring includes stop means cooperative with abutment means in said casing head annular recess to prevent excessive contraction of said ring.

4. A well casing hanger apparatus according to claim 1, wherein the inside surface of said seat ring is beveled at its edge facing said bore downhole opening, thereby forming a frusto-conical surface for camming said seat ring towards its expanded condition in response to the application of an axial force thereto by an abutment flange of an inserted well tool disposed between said ring and said downhole opening.