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(54) IMPROVEMENTS IN OR RELATING TO WELL-HEAD ASSEMBLIES

(71) We, FMC CORPORATION, a corporation organised and existing under the laws of the State of Delaware, United States of America, of 111 E. Wacker Drive, Chicago, State of Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to well-head apparatus, and more particularly to well casing head assemblies.

According to the present invention there is provided a full-opening well casing head assembly with a straight-through bore and an internal annular recess in said bore, said assembly comprising a split ring retractile seat element positioned in the annular recess for radial movement between an outwardly-expanded condition wherein said seat element is retracted into said recess, and a contracted condition wherein said seat element extends into said casing head bore in a functional, supporting position for a pipe or other member, and a cam mechanism, including cam means and rotatable shaft means fast with said cam means for expanding the seat element into the annular recess in response to rotation of said cam shaft means from a location exterior to said assembly.

Further according to the present invention there is provided a well head casing assembly comprising a head having an annular internal recess, a split-ring seat element and a cam lying between the free ends of the ring and operable from externally of the head to retract in one position thereof the element into the recess and in an alternative position to allow the element to contract to a position in which it can support a casing hanger or other member within the head.

Still further according to the present invention there is provided apparatus for supporting a pipe within a well, comprising a casing head with an axial, straight-through bore and an annular recess within said bore, and a substantially rectractile seat means retractable into the annular recess in response to an expansive force applied thereto, said seat means being inherently biased towards a contracted condition from its retracted position in said recess, and cam means for expanding said seat means from the contracted condition into the retracted position within the recess.

The embodiment of a well head casing assembly in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which: —

Figure 1 is an isometric view, partially broken away, of one embodiment of a retractile seat and full-opening well casing head assembly according to the present invention, showing the seat in its extended, functional position;

Figure 2 is a horizontal section of the casing head assembly of Figure 1, on line 2—2 of Fig. 1 and with parts removed;

Figure 3 is an isometric view of the retractile seat of the casing head assembly of Fig. 1;

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

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

Figure 6 is a fragmentary isometric view of the casing head assembly of Figure 1, showing the retractile seat in its contracted condition, and with parts broken away to better illustrate a cam mechanism for retracting the seat;

Figure 7 is a fragmentary side elevation of exterior components of the cam mechanism, as viewed in the direction of the arrow 7 of Figure 6;

Figure 8 is a view of Fig. 6, but with the seat in its expanded condition; and

Figure 9 is a view like Fig. 7, but as

viewed in the direction of the arrow 9 of Fig. 8.

Broadly considered, the well head assembly 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 and upper sections 18, 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 an unobstructed, straight-through bore 27 is formed in the casing head 10.

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 surfaces 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, as 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 split pin 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, inwardly 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 outwardly-retracted into the recess 42. The cam 70 has appropriately contoured opposite side surfaces 106, 108 that bear against the seat's opposed ends 44, 46, 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, inwardly-extended position (Figs. 1, 2, 4, 6 and 7). As best seen in Fig. 9, the cam 70 can be releasably locked when the seat is in its outwardly-retracted position in the seat by installation of the split pin 100 through the cam shaft's transverse bore 94, thereby preventing counter-clockwise rotation of the cam until the split pin 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 split pin 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 element 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 embodiment 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 hitherto proposed. 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.

WHAT WE CLAIM IS: —

1. A full-opening well casing head assembly with a straight-through bore and an internal annular recess in said bore, said assembly comprising a split ring retractile seat element positioned in the annular recess for radial movement between an outwardly-expanded condition wherein said seat element is retracted into said recess, and a contracted condition wherein said seat element extends into said casing head bore in a functional, supporting position for a pipe or other member, and a cam mechanism, including cam means and rotatable cam shaft means fast with said cam means for expanding the seat element into the annular recess in response to rotation of said cam shaft means from a location exterior to said assembly.

2. An assembly according to claim 1 wherein the seat element has a plurality of circumferentially-spaced axially-orientated grooves in its outer surface enhancing the expansibility thereof, and a radial, planar bottom surface for providing a secure support for said element in the said annular recess.

3. An assembly according to claim 1 or claim 2 wherein the split ring seat element has an upper surface with a frusto-conical portion for centering said seat element in the casing head by placing a well tool upon said portion.

4. An assembly according to any one of claims 1 to 3 wherein the inside surface of the split ring seat element is bevelled at its lower edge, thereby forming a frusto-conical surface for camming the seat element towards an outwardly expanded condition in response to the application of an upward axial force thereto.

5. An assembly according to any one of the preceding claims wherein the element has an upper annular flange at its outer edge.

6. An assembly according to any one of the preceding claims wherein the cam means is positioned in the split of said ring element and serves to expand the element when the cam shaft means is rotated.

7. An assembly according to claim 6 including cam rotation stop means on the exterior of the casing head, and means on the cam shaft co-operating with said cam rotation stop means to restrict the rotation of the cam between predetermined limits corresponding to expanded and contracted conditions of the seat element.

8. An assembly according to claim 7 including means for preventing rotation of the cam shaft from a position wherein the seat element is retracted into the recess in the casing head.

disposed at an inclined position (Figs. 8 and 9) approximately 105 degrees of rotation from the vertical when the seat 12 is fully outwardly-retracted into the recess 42. The cam 70 has appropriately contoured opposite side surfaces 106, 108 that bear against the seat's opposed ends 44, 46, 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, inwardly-extended position (Figs. 1, 2, 4, 6 and 7). As best seen in Fig. 9, the cam 70 can be releasably locked when the seat is in its outwardly-retracted position in the seat by installation of the split pin 100 through the cam shaft's transverse bore 94, thereby preventing counter-clockwise rotation of the cam until the split pin 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 split pin 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 element 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 embodiment 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 hitherto proposed. 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.

WHAT WE CLAIM IS:—

1. A full-opening well casing head assembly with a straight-through bore and an internal annular recess in said bore, said assembly comprising a split ring retractile seat element positioned in the annular recess for radial movement between an outwardly-expanded condition wherein said seat element is retracted into said recess, and a contracted condition wherein said seat element extends into said casing head bore in a functional, supporting position for a pipe or other member, and a cam mechanism, including cam means and rotatable cam shaft means fast with said cam means for expanding the seat element into the annular recess in response to rotation of said cam shaft means from a location exterior to said assembly.

2. An assembly according to claim 1 wherein the seat element has a plurality of circumferentially-spaced axially-orientated grooves in its outer surface enhancing the expansibility thereof, and a radial, planar bottom surface for providing a secure support for said element in the said annular recess.

3. An assembly according to claim 1 or claim 2 wherein the split ring seat element has an upper surface with a frusto-conical portion for centering said seat element in the casing head by placing a well tool upon said portion.

4. An assembly according to any one of claims 1 to 3 wherein the inside surface of the split ring seat element is bevelled at its lower edge, thereby forming a frusto-conical surface for camming the seat element towards an outwardly expanded condition in response to the application of an upward axial force thereto.

5. An assembly according to any one of the preceding claims wherein the element has an upper annular flange at its outer edge.

6. An assembly according to any one of the preceding claims wherein the cam means is positioned in the split of said ring element and serves to expand the element when the cam shaft means is rotated.

7. An assembly according to claim 6 including cam rotation stop means on the exterior of the casing head, and means on the cam shaft co-operating with said cam rotation stop means to restrict the rotation of the cam between predetermined limits corresponding to expanded and contracted conditions of the seat element.

8. An assembly according to claim 7 including means for preventing rotation of the cam shaft from a position wherein the seat element is retracted into the recess in the casing head.

* C L M S *

9. An assembly according to claim 7 wherein the cam shaft is rotatable through approximately 105 degrees between the limits of its rotation.

10. A well head casing assembly comprising a head having an annular internal recess, a split-ring seat element and a cam lying between the free ends of the ring and operable from externally of the head to retract in one position thereof the element into the recess and in an alternative position to allow the element to contract to a position in which it can support a casing hanger or other member within the head.

11. Apparatus for supporting a pipe within a well, comprising a casing head with an axial, straight-through bore and an annular recess within said bore, and a substantially retractile seat means retractable into the annular recess in response to an expansive force applied thereto, said seat means being inherently biased towards a contracted condition from its retracted position in said recess, and cam means for expanding said seat means from the contracted condition into the retracted position within the recess.

12. Apparatus according to claim 11 wherein the seat means comprises an axially split ring that is expandable from the said contracted condition in response to application of a circumferential force thereto by the cam means.

13. A well head casing assembly substantially as hereinbefore described with reference to the accompanying drawings.

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