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3,324,952

WELL TOOL CONTROL MECHANISM

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Fig. 1

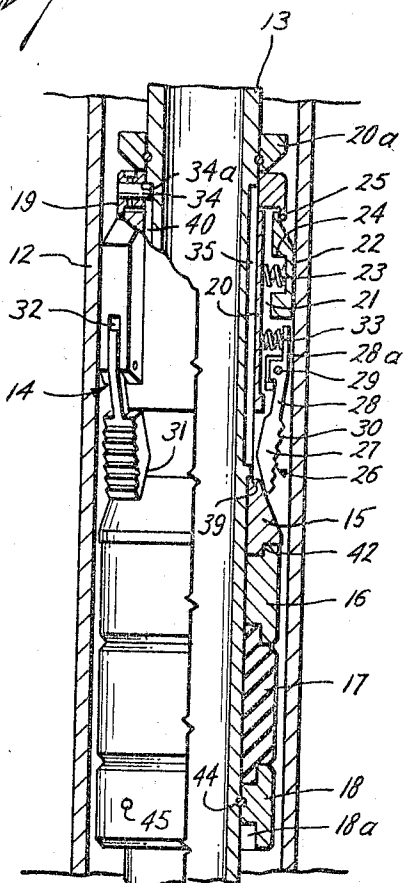


Fig. 2

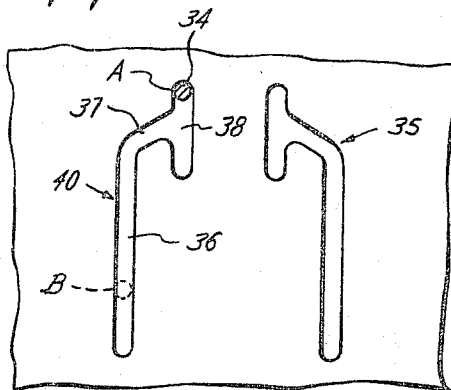


Fig. 4

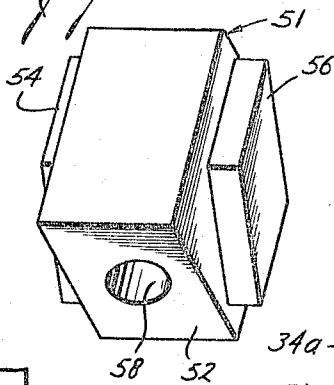


Fig. 3

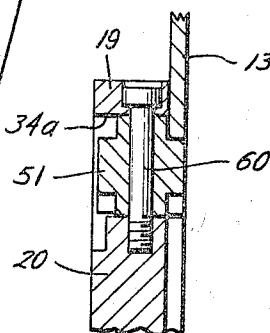
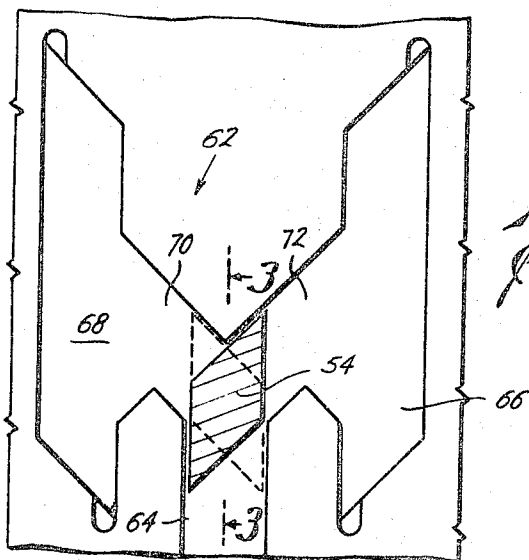


Fig. 5



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WELL TOOL CONTROL MECHANISM

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This invention relates to a well tool control mechanism and, more particularly, to a well tool J-slot arrangement which provides for selective control of movement between telescoping members of a well tool.

Tubing-type retrievable packers set in tension usually are comprised of an upper slip and drag block assembly in combination with a lower packer element. The packer is set by first unlocking a jaying mechanism and then applying tension to the tubing which sequentially sets the slips into the well casing and expands the packer element. The expanded packer element seals off an annulus between the casing and a mandrel of the packer. At some later time the packer can be retrieved by lowering the tubing which sequentially contracts the packer element and unlocks the slips from the casing. The packer is then locked in an inactive position by the jaying mechanism and retrieved.

Due to pressure considerations in the well bore, other packers are constructed for setting in compression wherein the weight of the tubing string is utilized to perform the setting operation.

Often, other tools in the tool string are operated by either longitudinal or rotative motion of the tubing and, therefore, the jaying mechanism in the packer must be operable in such a manner as to not inadvertently effect the operation of these other tools in the tool string.

It is, therefore, an object of the present invention to provide a new and improved jaying mechanism for the selective operation of a well tool.

Another object of this invention is to provide a new and improved jaying mechanism which permits selective operation of a well tool by longitudinal motion of the tubing string in either direction along with either right or left hand rotation of the tubing.

With these and other objects in view, the present invention involves a jaying mechanism which is shown in use with a well packer. The packer has a resilient element expandable by virtue of relative movement between telescoping members of the packer. An expander cone associated with one of the members actuates slips to provide a rigid stop for the one member against which movement of the other member expands the resilient element into engagement with the well to thereby pack-off the well. The relative movement between these members is controlled by a slot or channel system and follower lug arranged between the members. Means are provided for orienting the lug relative to the slot system to provide for selective operation of the packer by a variety of longitudinal and rotative motions.

FIG. 1 illustrates, in partial longitudinal cross section, details of a packer incorporating the jaying mechanism of the present invention;

FIG. 2 is a layout of the J-slot arrangement in the packer shown in FIG. 1;

FIG. 3 is an elevational view of part of a well tool including an alternative follower lug;

FIG. 4 is an isometric view of the follower lug shown in FIG. 3; and

FIG. 5 is a layout of a J-slot system which is utilized with the follower lug of FIGS. 3 and 4.

Referring to FIG. 1 of the drawings, a tension-packer is illustrated in a casing 12 at the lower end of a tubing string, not shown. If desired, a safety joint, bypass and other accessory tools can be connected in the tubing string

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above the packer. The packer has a longitudinally extending tubular mandrel 13 on which an upper drag block and slip assembly 14 is slidably mounted. A J-slot and J-pin, which will hereinafter be described, are used to control relative movement between assembly 14 and mandrel 13. Below the assembly 14 is an expander cone 15, an upper gauge ring 16, an elastomer packing element 17 and a lower gauge ring 18. The lower gauge ring 18 is releasably secured by shear means 44 to the mandrel 13. The cone moves with the mandrel to activate slips on the assembly whereupon the cone 15 is slidable relative to the mandrel to expand the packing element between the gauge rings 16 and 18.

The upper drag block and slip assembly 14 includes a tubular cage 20 (FIG. 2) slidably received on mandrel 13. A retainer ring 19 is positioned above the cage 20 and is also slidably received on the mandrel. A stop collar 20a is connected to the mandrel to limit upward movement of the cage 20 relative to the mandrel. Cage 20 has circumferentially spaced, longitudinal slots 21 which receive rectangularly shaped friction drag blocks 22. Between a drag block 22 and the cage is a coiled spring 23 to move a drag block radially outwardly into frictional engagement with the casing. Each block 22 has a bored recess 24 to receive the spring 23. Each block 22 also has end portions or flanges 25 (only one end shown) to retain the block in the cage.

Associated with each drag block 22 is a slip element 26 which has a head 27 and stem 28. To accommodate a slip element each drag block at its lower end has a slot 32 in which a stem 28 is received. A pin 29 pivotally interconnects the stem of a slip element to a block. Each slip head 27 is provided with external serrations or teeth 30 and an internal or inner tapered slip surface 31. Teeth 30 are formed by transverse slots which provide edges or inclined surfaces. Between slot 21 in the cage and a tang 28a on the end of the stem 28 of a slip element 26, a spring 33 is inserted to urge the tang 28a outwardly thus pivoting the slip element 26 about pin 29 to urge the head 27 of the slip element 26 inwardly toward mandrel 13.

The control means for releasably connecting the cage housing 20 to the mandrel 13 includes an inwardly projecting lug 34 and J-slots 35 and 40 in the wall of the mandrel. The lug 34 is positioned within an opening 34a formed in the retainer ring 19 and held in place by a bolt which screws into the tubular cage 20. This bolt may be used for removing the lug from the opening and rotating the upper drag block and slip assembly 14 so that the lug may be selectively operated in one or the other of the slots 35 or 40. As shown in FIG. 2, the J-slot 40 has a relatively long lengthwise-extending portion 36. When the packer is in the position shown in FIG. 1, that is, in condition for being run into a well, the lug 34 is disposed at a point A in the upper end of a short vertically extending portion 38 of the J-slot. The resistance caused by frictional engagement of the drag blocks with the casing allows the mandrel 13 to be moved relative to the upper drag block and slip assembly 14. A transverse portion 37 of the J-slot connects the portions 36 and 38 to permit movement of the lug 34 within the slot while rotation of the mandrel 13 is accompanied with vertical movement of the mandrel. When the lug 34 is disposed in the long longitudinally extending portion 36 of the J-slot, the mandrel 13 can be further shifted vertically relative to the drag block assembly 14.

Expander 15, positioned below the drag block assembly, has an outer relieved portion 42 at its lower end which provides a seat for a complementarily shaped portion in the upper end of the gauge ring 16. Upward travel

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of the cone 15, and upper gauge ring 16 is limited by a downwardly facing shoulder 39 on the mandrel 13.

The resilient elastomer packer element 17 is received by the mandrel and disposed between the upper and lower gauge rings 16 and 18.

The lower gauge ring 18 is connected to the mandrel 13 by a ring-like shear member 44 disposed partly in each of annular, complementarily arranged grooves respectively in the gauge ring 18 and mandrel 13. Member 44 can be inserted through a tangential passageway 45. An annular recess 18a is formed in the bottom or lower end of the gauge ring 18 sized to seat over a collar (not shown) should the gauge ring 18 be released by shearing of ring 44.

In operation of the apparatus thus far described, the packer 10 can be positioned in the casing. When the packer is in position for setting, the operator will first slack off with running in string and then pick up while torquing the pipe in a left-hand direction so as to align the lug 34 on the cage 20 with the longitudinally extending portion 36 of the J-slot 40 (see FIG. 2). It may be seen from FIGS. 1 and 2 that the direction of torquing may be reversed by reversing the J-slot arrangement, that is, by rotating the upper drag block and slip assembly 14 such that when the pin 34 is inserted, it will be aligned with the other J-slot 35 as shown in FIG. 2. Such an arrangement will accommodate right-hand torquing to align the lug 34 with the long longitudinally extending portion of slot 35.

As the mandrel 13 moves upwardly relative to the drag block assembly (which is frictionally held relative to the casing), the gauge rings 16, 18, packer element 17, and expander cone 15 move upwardly relative to the drag block assembly. The outer tapered surface of cone 15 engages the tapered sloping surface 31 on the slip head 27 so as to pivot the heads outwardly into gripping engagement with the well casing.

The holding teeth 30 on the slips grip the casing so that further upward movement on the cone is not possible. Further upward travel on the mandrel and gauge ring 18 will expand the resilient packer element 17 into sealing engagement with the inner wall of the casing. Packer element 17 when expanded provides an effective seal between the mandrel and the casing so long as the tension is maintained on the tubing 11. Lug 34, for example, can be in a position B as shown in FIG. 2 when the packer element is expanded.

To recover the packer from the well, it is only necessary to relieve the upward tension on the tubing string 11 and lower the tubing string so that the gauge ring 18 releases the compression on the packer element 17. Subsequently, shoulder 39 engages the cone 15 to move the cone downwardly relative to the slips. Cone 15, when moved from below slips 26, permits the slips to retract inwardly. Lug 34 moves from position B to the going-in position A.

Referring now to FIG. 3, a detailed view shows the opening 34a in retainer ring 19 with another embodiment of a lug 51 positioned therein. The details of this lug are shown in FIG. 4. The lug 51 is formed in the shape of a rectangular block 52 with right and left-hand indexing lug members 54, 56 formed thereon. An opening 58 is formed through the block to provide a means for securing the lug in the slot 34a by means of a bolt 60. The lug members 54, 56 are in the shape of parallelograms.

The developed view of a J-slot 62, to accommodate such lug members, is shown in FIG. 5. This J-slot has a single long longitudinally extending slot portion 64 and two short vertically extending portions 66 and 68 which provide for right and left-hand torque, respectively. Transverse portions 70, 72 of the slots connect the short vertical portions with the single long longitudinally extending portion. As shown in FIG. 5, the lug 54 is positioned in the slot in such a manner that the parallelogram-shaped lug member will move only through the transverse slot

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72 into the short vertical portion 66 of the slot to provide for a right-hand torque of the mandrel 13 in setting the packer. However, by turning the lug element 180 degrees about an axis formed by the opening 58, the lug member 56 will project into the J-slot as is shown by the dotted line in FIG. 5. Such an arrangement will permit movement of the lug only through the transverse slot 70 into the short vertical portion 68 thus providing a left-hand torquing motion for the packer setting operation.

It should be pointed out that the packer shown in FIG. 1 may be used as a compression set packer simply by inverting the tool so that the drag block and slip assembly is positioned at the lower end of the tool.

It is also appreciated that while the jaying system of the present invention is disclosed with a packer, the invention is applicable to other well tools which would utilize a J-slot and lug arrangement to control the relative movement between the members of the well tool.

Additionally, while a particular embodiment of the present invention has been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. In a well tool for use in a well bore, the combination of means for selectively controlling relative movement between telescoping members of the tool, which means comprises: a slot system and follower lug means between said members, said slot system including a pair of lengthwise channels and transverse channels connecting with each of said lengthwise channels, said transverse channels respectively extending in opposite directions relative to said lengthwise channels, said follower lug means cooperable with said channels, and means for positioning said lug means relative to said channel means for selective cooperation with only one of said lengthwise and connecting transverse channels.

2. In a well tool for use in a well bore and having a pair of telescoping members movable relative to one another, the combination of means for selectively controlling the relative movement of said members, which means comprises: one of said members having a longitudinally extending slot formed therein; at least two relatively transverse slots connecting with said longitudinal slot; lug means projecting from the other of said members and arranged to be movably received within said longitudinally extending slot and one of said transverse slots; and means for rearranging the orientation of said lug means on said other member to accommodate the movement of said lug in said longitudinally extending slot and a different one of said transverse slots.

3. In a well packer for use in a cased well, the combination of means for setting a packer element by relatively longitudinal and rotational movement between telescopically arranged tubular members, the movement selectively being in either of the longitudinal or rotative directions, which means comprises: a slot system and follower lug means between said members, said slot system including lengthwise channel means and connecting transverse channel means respectively extending in opposite directions relative to said channel means, and means for orienting said lug means relative to said channel means for selective cooperation with only one of said transverse channel means.

4. In a well tool for use in a well bore, the combination of means for selectively controlling relative movement between telescoping members of the tool, which means comprises: a slot system and follower lug means between said members, said slot system including lengthwise channel means and at least two connecting transverse channels respectively extending in opposite directions relative to said lengthwise channel means, said transverse channels each having surfaces inclined with respect

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to said lengthwise channel means, said surfaces connecting at an apex lying on the center line of said lengthwise channel means, said follower lug means cooperable with said lengthwise channel means and transverse channels, and means for orienting said lug means relative to said lengthwise channel means and transverse channels for selective cooperation with only one of said transverse channels.

5. Apparatus for use in a well tool to enable selective control of relative movement between tubular telescoping members, comprising: circumferentially spaced slot means in one of said members, each of said slot means including longitudinal segments connected together by transverse segments, said transverse segments extending in opposite directions relative to said longitudinal segments; lug means on the other of said members adapted to engage in said slot means; and means for locating said

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lug means in only a selected one of said spaced slot means so that relative movement between said members can be effected by longitudinal motion coupled with rotation in one direction or the other depending on the selection of location for said lug means.

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