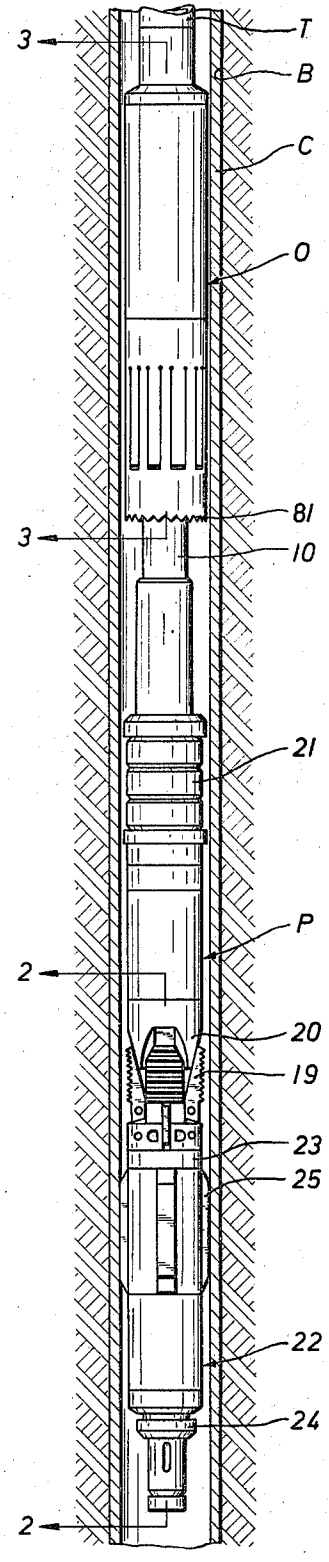
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RUNNING APPARATUS FOR WELL TOOLS

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FIG. 1



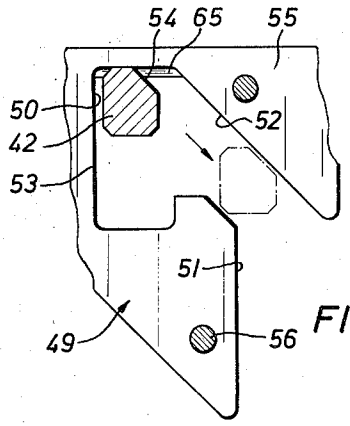


FIG. 5

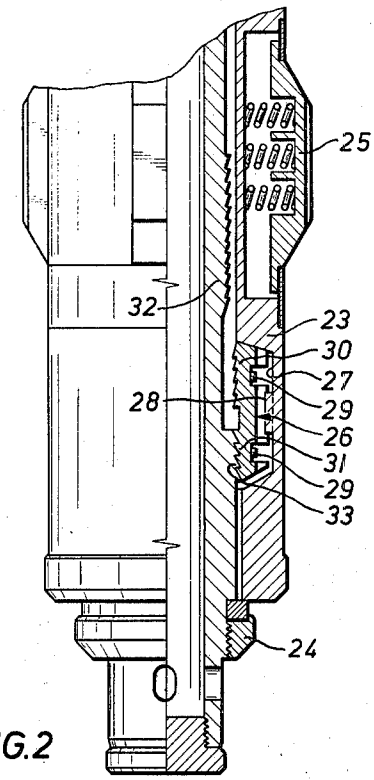


FIG. 2

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FIG. 3

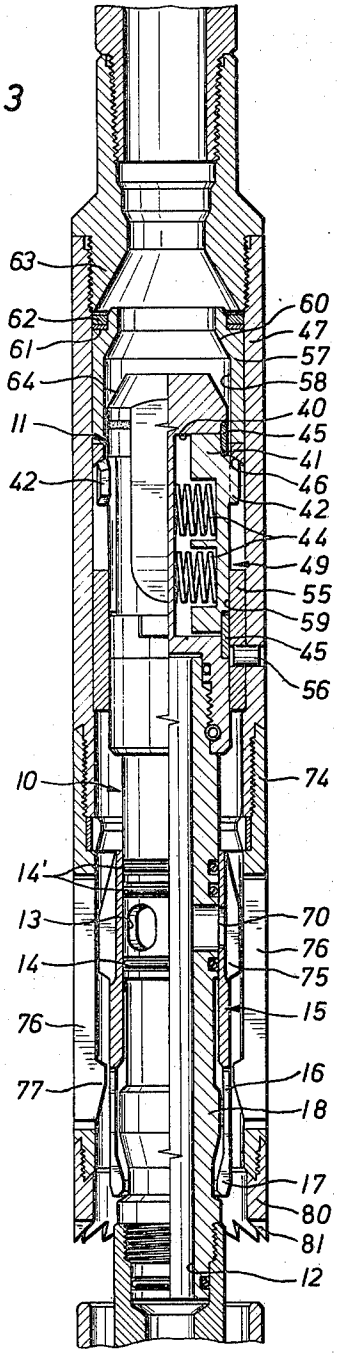
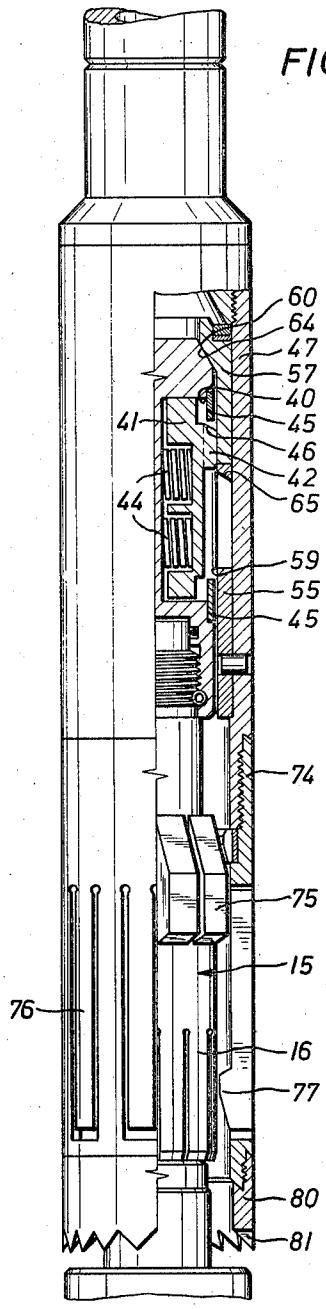


FIG. 4



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RUNNING APPARATUS FOR WELL TOOLS

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ABSTRACT OF THE DISCLOSURE

The particular embodiment described herein as illustrative of one form of the invention is directed to an apparatus for running retrievable well tools in the well bores and which can be operated by longitudinal movement and all right-hand rotation. The apparatus includes a barrel member which fits over the connector head of the well tool and which has an internal latching recess cooperable with laterally shiftable lugs on the connector head to couple the barrel thereto in one longitudinal relative position. In response to downward movement of the barrel relative to the connector head to another relative position, the lugs are shifted inwardly to a disengaged position where relative rotation will disalign the lugs and the latching recess to permit the barrel to be withdrawn from the connector head by a straight upward pull thereon.

This invention relates to a running apparatus for well tools, and more particularly, to an apparatus for running-in, setting, disconnecting from and later retrieving well tools in well bores.

In conducting various types of well completion operations such as acidizing, cementing, fracturing or testing, various types of well tools are run into a well bore on a pipe string and temporarily set therein. Later, some or all of the well tools can be retrieved to the surface. One well tool which is commonly run-in, set, disconnected from the pipe string and then later retrieved is a retrievable bridge plug which is dependently coupled below an upper packer by means of a running tool or "overshot" which is releasably coupled to a connector head on the bridge plug.

In order to set the bridge plug, movement of the tubing string is generally necessary. At the surface, there are, for all practical purposes, four types of manipulations which can be applied to the pipe string in order to operate the tools. These include downwardly and upward movement of the pipe string, and left- and right-hand rotation of the pipe string. Inasmuch as the pipe string is constituted by a plurality of joints which are connected together with right-hand threads tightly made up in order to convey fluids under pressure, any significant amount of left-hand rotation should be avoided because of the risk of backing off threaded joints. This problem is particularly evident in deviated wells because of pipe friction against the well bore wall.

Accordingly, it has been customary where rotation is necessary, to provide right-hand rotation to operate the tools. For example, retrievable packers and plugs often include a double threaded clutch assembly which enables both setting and unsetting by right-hand rotation. However, it will be appreciated that this has heretofore necessitated that the running tool be released by manipulations which include at least a portion of a turn to the left. This is due to the fact that a "J-slot" coupling has generally been used between the running tool and the bridge plug. This type of coupling will transmit right-hand rotation of the pipe string for setting and unsetting the plug, however a part turn of rotation to the left is used in order to disengage the coupling. In a straight bore hole, there is no

harm in such quarter turn rotation. However in deviated holes where there may be binding of the pipe string, the rotation to disconnect the J-slot connection could result in torquing the pipe string to the extent necessary to unthread it.

Accordingly, it is an object of the present invention to provide an apparatus for running-in, setting, disconnecting from and retrieving retrievable well tools, the apparatus being constructed and arranged so as not to require any left-hand rotation whatever.

It is another object of the present invention to provide a coupling between a pipe string and a well tool which has interlocking means transmitting unidirectional rotation in one direction, and which can be disconnected without rotation in the opposite direction.

These and other objects are attained in accordance with the present invention by the provision of an apparatus including inner and outer telescoping members which are movable longitudinally relative to one another between longitudinally spaced positions. In one position, means are provided to releasably interlock the members together for rotation in one direction. In the other position, one member can be rotated relative to the other in the same direction to a condition whereby the members can be withdrawn from one another without re-engaging said interlocking means, thereby enabling release by a straight upward pull. Thus, the direction of rotation can always be right-hand in manipulating the members.

The present invention has other objects and advantages which will become more clearly apparent from the following detailed description. The novel features of the present invention are set forth with particularity in the appended claims, while a preferred embodiment is illustrated in the accompanying drawings in which:

FIGURE 1 is a longitudinal sectional view illustrating a well tool being run into the well bore with the running tool of the present invention;

FIGURE 2 is a partial cross-sectional view with portions in side elevation of the lower portion of the well tool taken generally along lines 2—2 of FIGURE 1;

FIGURE 3 is an enlarged cross-sectional view of the running tool illustrated in FIGURE 1 taken generally along lines 3—3 of FIGURE 1;

FIGURE 4 is a view similar to FIGURE 3 but with the members in another telescoped position; and

FIGURE 5 is a developed schematic view showing the releasable interlocking connection between the members.

Referring initially to FIGURE 1, a typical well bore B is lined with a conduit or casing C which traverses earth formations. Extending into the well casing is a running-in string of drill pipe or tubing which is detachably connected to a retrievable bridge plug P by means of a running tool or overshot O. The bridge plug can be run into the well bore to a desired depth and then set, whereupon the running tool can be manipulated to disconnect the pipe string. In set position, the bridge plug P blocks fluid flow in either direction. While a retrievable bridge plug is shown for purposes of describing a specific embodiment of the invention, it will be understood that the running tool of the present invention may be utilized with other retrievable well tools such as packers and retainers.

As can be seen in FIGURES 1 and 3, the bridge plug P has a central mandrel or body **10** with a connector head **11** at its upper end and which carries a packing structure **21** adapted to be expanded into sealing contact with the well casing wall. A slidable sleeve valve **15** can be moved between a lower position permitting fluid bypass through the bore **12** of the mandrel **10** via lateral ports **13**, and an upper position closing off the ports **13** to fluid flow. The mandrel **10** further carries an expander

member 20 which is cooperable with normally retracted slips 19 to anchor against movement in the casing. The slips 19 can be pivotally mounted on a tubular cage 23 having drag elements 25 which resist movement in the casing and enable control over relative movement and various parts of the bridge plug. As shown in FIGURE 2, the cage 23 has an internal recess 27 which houses a segmental clutch nut 26. Each of the clutch nut segments is secured against rotation relative to the cage member 23 by lugs 28 which engage in peripheral slots in the segments. Band springs 29 permit lateral movement of the nut segments while continuously urging the segments toward contracted positions around the mandrel. Each nut segment has upper right-hand threads 30 and lower left-hand threads 31 which cooperate with companion spaced threads 32 and 33 on the mandrel 10 to secure the mandrel relative to the cage member in spaced longitudinal positions. When the threads 31 and 33 are engaged, the cage 23 is secured against upwardly movement along the mandrel 10, whereas when the threads 30 and 32 are engaged, the mandrel is secured against upwardly movement relative to the cage. Such relative movement can occur only by rotating the mandrel 10 to the right to disengage the respective threads. However, due to the buttress form of the threads, the upper mandrel teeth 32 can be ratcheted downwardly through upper segment threads 30 without rotation, and the lower mandrel threads 33 can likewise be ratcheted upwardly through and into engagement with the segment threads 31 without rotation.

As can be seen from the foregoing, the manipulations of the pipe string T which can be used to set and release the bridge plug P are right-hand rotation and longitudinal movement. As previously mentioned, the bridge plug P is provided with a connector head 11 which is engaged with the running tool O to transmit these manipulations of the pipe string to the mandrel. With this in mind, attention is directed to FIGURE 3, which illustrates details of the running tool O and its cooperative relationship with the connector head 11.

The head 11 is provided with two diametrically opposed, radially extending recesses 40. Positioned in each recess is a lug block 41 having an outwardly extending lug member 42 on its outer periphery. Each lug block 41 is biased outwardly by coil springs 44, outward movement being limited by bands 45. The recess 40 is deep enough so that the lug block 41 can move inwardly to a position whereby the lug 42 will not protrude past the peripheral surface of connector head 11. The top surface 46 of the lug 42 is formed to incline downwardly and outwardly.

The running tool O has a barrel member 47 which telescopes over the connector head 11. In effect, the connector head 11 becomes an inner telescoping member and the barrel member becomes an outer telescoping member. A latch sleeve 55 is secured within the barrel member 47 by pins 56 or the like so that the latch sleeve cannot rotate relative to the barrel member. The latch sleeve 55 has opposed guide and latching configurations 49, one of which is shown in FIGURE 5 as including a downwardly opening channel 51 which is connected by an inclined channel 52 to a closed-end channel 50. Thus, when the barrel member 47 is rotated to the right by the pipe string T, the vertical walls 53 of the channels 50 will be engaged by the lugs 42 whereby the mandrel 10 will be rotated to the right. The upper end surfaces 59 of the channels 50 are formed to incline upwardly and inwardly and can engage the upper surfaces 46 on the lugs 42 in a manner whereby a predetermined downward force on the barrel member 47 will cause the lug blocks 41 to be shifted inwardly against the action of the springs 44.

A freely rotatable sleeve 57 is positioned within the barrel member 47 above the fixed sleeve 55. The rotatable sleeve 57 has a bore 58 with the same diameter as the bore through the sleeve 55. The upper end of sleeve 57 terminates in an inwardly tapered shoulder 60. The upper end of the sleeve 57 can be formed with a pocket 61 which receives bearing members 62 engaging the lower end of a collar 63 which attaches the barrel member 47 to the lower end of the pipe string. The upper end of connector head 11 may be provided with a tapered surface 64 for engagement with the shoulder 60 on the sleeve 57.

A lower portion of the barrel member 47 is longitudinally and transversely slotted to provide a plurality of spring fingers 76 having enlarged head portions 77 which can flex outwardly. The valve sleeve 15 also has flexible spring fingers 16 extending downward and terminating in enlarged portions 17. The enlarged portions 17 can engage alternatively above and below an annular shoulder 18 on the mandrel 10 to releasably retain the valve sleeve in either closed or open position. The head portions 77 on the barrel member 47 can engage enlargements 75 on the valve sleeve 15 to cause the valve sleeve to slide along the mandrel 10 between upper and lower positions. When the valve sleeve 15 is in its lower position engaging the mandrel shoulder 18, downward force on the barrel member 47 will cause the head portions 77 to flex outwardly and ride over the enlargements 75. Then when the barrel member 47 is elevated, the head portions will engage the valve sleeve and pull it upwardly to its closed position, whereupon the head portions 77 will again be shifted outwardly to ride over the enlargements 75. The lower end portion of the barrel member 47 can constitute a milling shoe 80 having teeth 81 for cutting away settlement and debris on top of the tool when the running tool is engaged.

In operation, the bridge plug P is run into the well bore as previously described. The barrel member 47 is telescoped over the connector head 11 and the lugs 42 are engaged in the closed-end channels 50 in the fixed sleeve 55. The valve sleeve 15 is in its lower position permitting fluid bypass through the ports 13. To set the plug, the mandrel 10 is rotated by the pipe string T to the right while slacking off to release the clutch assembly 22, whereupon the weight of the pipe string is imposed on the bridge plug to expand the slips and the packer elements. As the mandrel 10 moves downwardly, the upper mandrel threads 32 can ratchet through the upper segment threads 30 which engage to trap the mandrel in the lowermost position to which it is moved. When a predetermined magnitude of weight has been applied, the coaction between the inclined surfaces 46 and 65 on the lugs 42 and the sleeve 55, respectively, causes the lug blocks 41 to shift inwardly against the action of springs 44. With the blocks 41 fully retracted, the barrel member 47 can move relatively downwardly with the lugs 42 sliding on the wall of the bore 58 as shown in FIGURE 4. Downward movement is stopped when the tapered surface 64 on top of connector head 11 contacts the shoulder 60 on the sleeve 57. At this point, the barrel member 47 is free-wheeling relative to the connector head 11 so that further right-hand rotation of the pipe string will radially disalign the closed-end recesses 50 and the lugs 42. Then the pipe string can be simply pulled straight upwardly and the running tool disengaged. This can occur because the lugs 42 must be fairly accurately aligned with the closed-end recesses 50 in order for re-engagement to occur. In the great majority of cases, the parts will be disaligned and the lugs 42 will be held inwardly by inner wall surfaces of the sleeve 55 until the sleeve is drawn upwardly over the lugs. If the sleeve 55 is not properly disaligned, this will be observed immediately at the surface and the pipe string can be slacked off again until the coil spring compression is overcome and the lugs again engage the bore surface 58 of sleeve 57. The pipe string is then rotated and withdrawal again attempted.

As the barrel member 47 is withdrawn upwardly, the head portions 77 engage the valve sleeve enlargements 75 to pull the valve sleeve 15 to its upper closed position

spanning the port 13. In this position, seals 14 and 14' prevent fluid leakage so that the bridge plug P entirely blocks the well bore.

Accordingly, it can be seen that a running tool is provided with an interlock which in one position permits rotation in one direction of the mandrel by the pipe string, and which can be moved to another position which enables release without rotation in the opposite direction. The present invention thus permits an all right-hand system for use in running retrievable tools in well bores. Of course, it will be appreciated that the lugs 42 can be disengaged from the latch sleeve 55 by a quarter turn left-hand rotation of the pipe string in the usual manner, where conditions permit such left-hand rotation.

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 the invention in its broader aspects; and therefore, the aim of the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. Apparatus for use in a well bore comprising: inner and outer telescoping members movable longitudinally relative to one another between longitudinally spaced positions; interlocking means including laterally shiftable latch means on one of said members and recess means on the other of; said members for transmitting rotation between said members in one direction in one of said positions; and means including coengageable inclined surfaces on said latch means and said recess means for shifting said latch means out of said recess means in response to relative movement of said members to another of said positions and further rotation in said one direction to release said interlocking means and permit withdrawal of said members from one another by longitudinal movement only.

2. Apparatus for use in releasably coupling a well tool to the lower end of a pipe string, said well tool having an upwardly extending connector member, comprising: an elongated tubular member extendible over said connector member and adapted for connection to the pipe string; laterally shiftable latch means on one of said members; guide means on the other of said members and including a recess in which said latch means can engage to co-rotatively secure said members together in one longitudinal relative position of said members; and means on said other member engageable with said latch means and responsive to downward movement of said tubular member to another relative position for shifting said latch means laterally and out of said recess to permit free relative rotation of said members.

3. The apparatus of claim 2 wherein said guide means includes a downwardly open channel through which said latch means can pass in coupling said member together, said channel being circumferentially spaced from said recess, and an inclined channel engageable with said latch means to automatically guide said latch means into said recess.

4. The apparatus of claim 2 wherein said shifting means includes an inclined surface forming a wall of said recess and engageable with an inclined surface on said latch means.

5. The apparatus of claim 2 further including surface means on said other member which can prevent re-engagement of said latch means in said recess during upward movement of said other member from said other relative position.

6. Apparatus for use in releasably coupling a well tool to a pipe string in a well bore, said well tool having an upwardly extending connector head with at least one laterally shiftable lug means which extends outwardly of the peripheral wall of the connector head, the combination comprising: a barrel member adapted for connection to the lower end of the pipe string and extendible over said connector head, guide means extending about the inner periphery of said barrel member and having a latching recess cooperating with said lug means to co-rotatively secure said barrel member to said connector head; a rotatable sleeve positioned in said barrel member above said guide means; means responsive to lowering of the pipe string for shifting said lug means out of said recess to permit said barrel member to move downwardly on said connector head so that said lug means will engage the inside of said sleeve, whereby further relative rotation between said barrel member and said connector will misalign said lug means and said latching recess.

7. The apparatus of claim 6 wherein said lug means includes a plurality of lug blocks positioned in pockets in said connector head, said lug blocks each having a projection thereon, and spring means for urging said blocks outward, the depth of each pocket being sufficient to accommodate inward movement of a lug block to an extent whereby the projection does not extend past the peripheral wall of said connector head.

8. The apparatus of claim 6 wherein said sleeve is provided with an inwardly extending shoulder to limit downward movement of said barrel member.

9. The apparatus of claim 6 wherein said guide means further includes an open channel extending downwardly from the latching recess, and an inclined channel extending from said latching recess to said open channel.

10. The apparatus of claim 9 wherein said shifting means includes cooperative inclined surfaces on said lug and said guide means.

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U.S. Cl. X.R.

166—237; 285—317, 361