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WELL TOOL CLUTCH SYSTEM

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Fig. 1

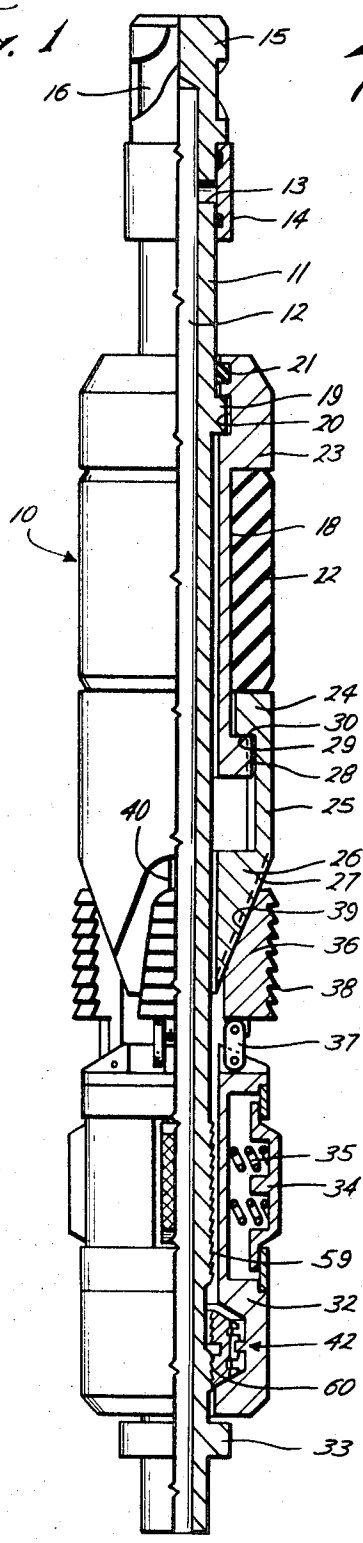


Fig. 2

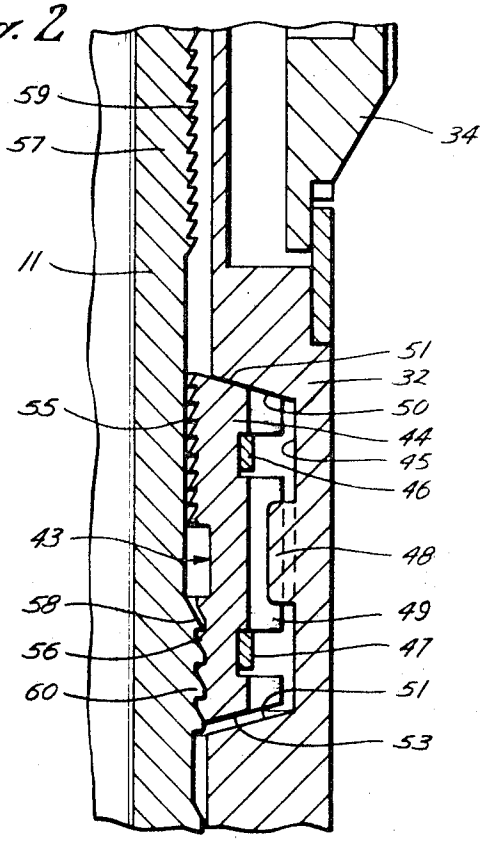
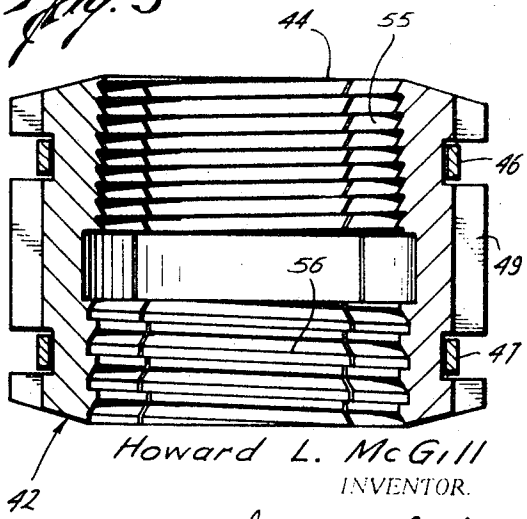


Fig. 3



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WELL TOOL CLUTCH SYSTEM

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ABSTRACT OF THE DISCLOSURE

The particular embodiment disclosed herein as illustrative of one form of the invention is a selectively operable coupling device for controlling relative movement between telescoping members in a well tool including a segmental nut member between said members and arranged for lateral movement, means for securing said nut member against rotation relative to one of said members, spaced upper and lower thread portions on said nut member having opposite lead threads, and spaced upper and lower companion threads on the other of said members respectively engageable with threaded portions on said nut member to prevent relative movement, and releasable therefrom to permit relative movement in response to rotation of one of said members relative to the other in one rotational direction.

The present invention relates generally to well tools, and more specifically to a selectively manipulatable device for controlling relative movement between parts of a well tool.

Many well tools have expansible elements such as slips and packing which are expanded in a well conduit in response to manipulation of a running-in string of tubing or drill pipe extending from the tool to the earth's surface. Since the tool must first be moved through the well conduit to a predetermined depth of setting, it is desirable to prevent any premature expansion or operation of parts during lowering. This necessitates the use of a control device which can lock the tool parts against relative movement during lowering and which can be manipulated at setting depth from locked to released condition. Moreover, once the tool is set, it may be desirable to lock the various parts in set condition so that the tool will remain set in the well conduit until it is desired to remove it. Accordingly, the control mechanism should have the further capability of again locking the various parts against relative movement in set positions. Then at some later time it may be desirable to remove the tool of the well conduit, whereupon the control mechanism should be manipulatable to a released condition to permit relative movement to occur in retracting the slips and packing. Finally, it is usually desirable to again lock the various parts in their initial retracted relative position for longitudinal movement in the well conduit.

The motions which normally can be applied to the running-in string at the earth's surface to operate such a control device are rotational motion in either direction and/or vertical motion, either upward or downward. One control device which is responsive to these manipulations and has the above-mentioned capabilities is the so-called clutch nut or "dizzy" nut system which comprises an expansible and contractable nut member having threads which are cooperable with mating threads on a mandrel to prevent relative movement when engaged, and which are releasable by relative rotation to permit longitudinal relative movement. Then the threads can be reengaged by vertical movement without rotation due to the one-way ratcheting characteristics of the device.

In the prior art, several different structural arrangements have been used. For example, U.S. Patent No. 3,279,542 issued to Brown shows separate upper and lower clutch nuts which are alternatively engageable with spaced mandrel threads. This system may function quite effectively, but has the disadvantage that its use necessitates a rather lengthy slip cage, with consequent increase in manufacturing costs and loss of tool compactness. Another clutch nut arrangement is used in the well tool illustrated in the Oilfield Composite Catalog, 1966–67, on page 552, wherein a single clutch nut has alternate segments with reverse lead threads which are respectively alternatively engageable with spaced mandrel threads. This system has the disadvantage that the threads are in engagement only around one-half the thread circumference, resulting in poor load distribution and structural weakness. Still another clutch nut arrangement is shown in U.S. Patent No. 2,893,492 issued to Brown wherein each clutch nut segment has reverse lead threads which are alternatively engageable with spaced reverse lead mandrel threads. This nut configuration is quite difficult to machine and the thread forms are structurally weak, particularly at points where the thread forms intersect each other.

The present invention is directed to a new and improved clutch nut arrangement which is cooperable with spaced, reverse lead thread sections on a mandrel to enable selective locking of the mandrel in various longitudinal positions relative to an outer tubular member, as well as selective release from locked condition for longitudinal movement between locked positions. Only a single clutch nut assembly is used so that the system is compact to reduce manufacturing costs. The nut assembly has longitudinally spaced threads to enable full circle engagement with respective mandrel threads. Thus, loads are evenly distributed between threads to enhance the strength and load bearing characteristics of the system. The respective thread sections are not coextensive, so that the nut assembly is easily manufactured.

The present invention may be summarized from a conceptual standpoint as a releasable coupling device for use in a well tool to control relative movement between tubular telescoping members. The coupling device includes radially movable, inwardly biased means between said members having longitudinally spaced threaded portions which are respectively engageable with spaced threaded portions on one of said members. Means are provided for preventing relative rotation between said means and the other of said members. The respective threaded portions are constructed and arranged to be engaged with one another in response to longitudinal relative movement without rotation, and to be disengaged only in response to relative rotation, preferably in response to rotation in the same hand direction.

The present invention has other concepts and advantages which will become more clearly apparent in connection with the following detailed description. A preferred embodiment is shown in the accompanying drawings, in which:

FIGURE 1 is a somewhat schematic cross-sectional view, with portions in side elevation, of a well tool which embodies the principles of the present invention;

FIGURE 2 is an enlarged fragmentary cross-section view of the present invention to show further structural details thereof; and

FIGURE 3, is a sectional view of the clutch nut assembly of FIGURE 2.

Referring initially to FIGURE 1, the present invention is illustrated in connection with a well tool **10** for use in a well bore. The well tool **10**, although shown in a bridge plug form, can be any type of well device where it is desirable to lock an inner tubular member, such as a central body or mandrel, in more than one longitudinal position relative to an outer tubular member, such as

a slip cage. One of the relative positions may correspond to the running-in condition of the tool where slips and packing are retracted. In the other relative positions, the slips and the packing may be expanded into respective gripping and sealing engagement with a well conduit wall.

The well tool **10** is shown as comprising a central mandrel **11** having a blind bore **12** and side ports **13** which can be opened and closed by a valve sleeve **14**. A connector head **15** on the upper end of the mandrel **11** has a slot system **16** to provide a means for releasably connecting the mandrel to a running-in string of drill pipe or tubing (not shown). The mandrel **11** is rotatively coupled to a compression sleeve member **18** by an annular shoulder **19** which engages within a recess **20** in the sleeve member. An elastomeric packing element **22** is mounted around the sleeve member **18** with its upper end engaging an annular abutment **23** on the sleeve member. A lower annular abutment **24** is slidable on the sleeve member **18** and engages the lower end of the packing element. Thus the packing element **22** may be compressed and expanded in response to movement of the abutments **23** and **24** relatively toward each other. A suitable seal ring **21** can be provided for preventing fluid leakage between the sleeve member **18** and the mandrel **11**.

The lower abutment **24** may be supported by a sleeve **25** which is connected to an expander cone **26** having downward and inwardly inclined outer surfaces **27**. The expander cone **26** can be coupled against rotation relative to the compression sleeve **18** by coengaging splines **28** or the like. Coengageable shoulders **29** and **30** are provided to limit downward movement of the expander cone **26** relative to the compression sleeve **18**.

A tubular cage member **32** is movably mounted on the lower end portion of the mandrel **11** above an annular stop ring **33** which limits downward movement of the cage member relative to the mandrel. A plurality of conventional drag blocks **34** are carried by the cage member **32** and are urged outwardly by coil springs **35** or the like. Moreover, a plurality of slip elements **36** are pivotally connected to the upper end of the cage member **32** by reins **37**, the slip members having wickers or teeth **38** on their outer faces as well as inner inclined surfaces **39** which are companion in shape to the expander cone surfaces **27**. Thus the slip elements **36** can be shifted outwardly into gripping engagement with a well conduit wall by downward movement of the expander cone **26** relative to the slip elements, and a conventional dove-tail tongue and groove connection **40** can be provided to effect inward retraction of the slip elements upon upward movement of the expander cone **26** relative to the cage member **32**.

A clutch nut assembly **42** in accordance with the present invention is provided to enable selective control over relative movement between the mandrel **11** and the cage member **32**. With particular reference to the somewhat enlarged drawing FIGURES 2 and 3, the clutch nut assembly **42** comprises an annular member **43** which is radially cut into a plurality of segments **44**, for example, four. The nut member **43** is received within an annular recess **45** which is somewhat enlarged relative to the nut member to accommodate lateral expansion and contraction of the segments **44**. Upper and lower resilient members such as band springs **46** and **47** are received within respective grooves in the segments and encompass the nut member **43**. Thus the segments **44** can expand and contract laterally while being constantly urged inwardly by the band springs **46** and **47**. Relative rotation between the various segments **44** and the cage member **32** can be prevented by lugs **48** projecting inwardly into vertically extending slots **49** formed in the periphery of each segment. The upper and lower walls of the recess **45** can be formed as oppositely inclined surfaces **50** and **51**, which are shaped for engagement with upper and lower inclined end surfaces **52** and **53** on the respective nut segments **44**.

Each segment **44** has spaced upper and lower threaded sections with teeth **55** and **56** of the buttress type having transverse surfaces facing respectively downwardly and upwardly. The upper threads **55** are of a relatively fine-thread construction and are formed on a left-hand helix, while the lower threads **56** are relatively coarse and are formed on a right-hand helix. The lower threads **56** are formed to have a through bore size which is at least as great as the root diameter of the upper threads **55**.

The mandrel **11** is formed to have spaced upper and lower threaded portions **57** and **58**, the upper threads **59** being companion in shape and size to the upper segment threads **55** and the lower threads **60** being companion in shape and size to the lower segment threads **56**. Thus the upper threads **59** have transverse surfaces facing upwardly and are left-hand threads, while the lower threads **60** have transverse surfaces facing downwardly and are right-hand threads. The lower mandrel threads **60** can be formed over a vertical extent approximately equal to the vertical extent of the lower segment threads **56**, while the upper mandrel threads **59** can be formed over a significantly greater peripheral extent of the mandrel **11**. Thus the lower mandrel and segment threads **60** and **56** may have a single relative point of engagement, while the upper mandrel and segment threads **59** and **55** can be engaged over a relatively wide range of relative positions of the mandrel **11** and the cage member **32**. Due to the formation of the various threads, the lower mandrel threads **60** can be screwed downwardly and disengaged from the lower segment threads **56** in response to right-hand rotation of the mandrel; continued downward mandrel movement without rotation will cause the upper mandrel threads **59** to ratchet through and engage the upper segment threads **55**. In like manner, right-hand rotation of the mandrel **11** can cause the upper mandrel threads **59** to screw upwardly out of engagement with the upper segment threads **55**. Continued upward mandrel movement without rotation will cause the lower mandrel threads **60** to ratchet back into engagement with the lower segment threads **56**.

OPERATION

The present invention can be assembled as shown in the drawings and lowered into a well conduit with the mandrel **11** coupled to a running-in string of tubing or drill pipe. The drag blocks **34** frictionally engage the inner conduit wall to yieldably resist movement in a conventional manner. The mandrel **11** is extended relative to the slip cage **32**, and the slips **36** and packing element **22** are in normally retracted positions. The lower mandrel threads **60** engage the lower threads **56** of the nut segment **44** to prevent upward movement of the cage member **32** relative to the mandrel **11**, thus preventing upward movement of the slips **36** toward the expander cone **26** during downward shifting of the tool to setting depth. Inasmuch as the slips **36** cannot move toward the expander cone **26**, or vice versa, the slips cannot be inadvertently shifted into gripping engagement with the well conduit during lowering.

When it is desired to set the tool, of course the tool is halted, and then the mandrel **11** is rotated by the running-in string to the right. If desired, such right-hand rotation can be accompanied with a small amount of further lowering movement of the mandrel **11**. The drag blocks **34** will prevent rotation of the cage member **32**, and since the nut segments **44** cannot rotate relative to the cage member due to engagement of the lugs **48** within the slots **49**, it will be appreciated that the lower mandrel threads **60** will be screwed downwardly and out of engagement with the lower segment threads **56**, thereby enabling downward movement of the mandrel **11** relative to the cage member **32** without further rotation. The coarse construction of the threads **56** and **60** enables release in response to only a very few turns of the running-in string. Such downward movement will effect expan-

sion of the slips **36** into gripping and supporting engagement with the well conduit, whereupon the weight of the running-in string may be imposed upon the mandrel **11** to compress and expand the packing element **22**. As the mandrel **11** is thus moved downwardly, the relatively fine upper mandrel threads **59** will ratchet through the companion upper segment threads **55** due to the camming action of the lower thread faces against corresponding faces on the segment threads, and to the ability of the segments to expand and contract laterally while being constanly urged inwardly by the band springs **46** and **47**. Inasmuch as the bore through the lower segment threads **56** is at least as large as the root diameter of the upper mandrel threads **55**, the upper mandrel threads can readily pass downwardly through the lower segment threads **56** without interference. Due to the upwardly and downwardly facing form of the respective mandrel and segment threads **59** and **55**, it will be apparent that the mandrel **11** will become trapped in the lowermost position to which it is moved relative to the cage member **32** to trap compression loading in the packing element **22** and thereby lock the tool in set condition. The fine-thread construction of the threads **55** and **59** enables efficient trapping of the compression loading in the packing element **22** because the relatively small pitch of these threads ensures that all or practically all of the downward movement of the mandrel to be retained by the clutch nut assembly **42**. The upper mandrel threads **59** can have a considerable vertical extent to accommodate a wide range of relative movement requirements for expanding the slips **26** and the packing element **22**.

With the tool locked in set condition, it will remain until it is desired to remove it from the well. Removal of the tool may be accomplished by rotating the mandrel **11**, again to the right, relative to the cage member **32**. By virtue of the left-hand formation of the threads **59** and **55**, right-hand rotation of the mandrel will result in upward feeding of the mandrel relative to the cage member. Such right-hand rotation may be accompanied by upward strain on the running-in string if desired. Upward movement of the mandrel **11** relative to the cage member **32** will effect release of compressive force on the packing element **22**, which will inherently retract, and eventual upward movement of the expander cone **26** relative to the slips **26**, causing the latter to shift inwardly to retracted positions. Upward movement of the mandrel **11** can be continued until the lower end surface of the cage member **32** shoulders against the gauge ring stop **33**, at which point the lower mandrel threads **60** will have ratcheted back into engagement with the lower segment threads **56**. Accordingly, the cage member **32** is again secured against longitudinal movement relative to the mandrel **11**, and the tool can be retrieved from the well or moved to another setting position.

Since only one clutch nut assembly **42** is utilized in accordance with the present invention, the overall length of the cage member **32** can be relatively short to increase the compactness of the tool and reduce manufacturing costs. Since the respective upper and lower segment threads **55** and **56** extend continuously about respective inner peripheral portions of each segment **44**, there is substantially full circle engagement with the mandrel threads **59** and **60** to evenly distribute the loading therebetween. Finally, since the lower segment threads **56** are sized to pass the upper mandrel threads **59** without interference, the upper mandrel and segment threads **59** and **55** can be expeditiously engaged without undue lateral ratcheting action of the segments **44** so as to obviate the problems of cocking and canting and failure to properly engage. Since certain changes or modifications may be made in the present invention without departing from the inventive concepts involved, it is the aim of the appended claims to cover all such changes and modifications falling within the true spirit and scope of the present invention.

I claim:

1. In a well packer apparatus having settable packing and adapted to be releasably locked in both the running or retrieving and the set conditions in a well bore, the improvement comprising: a body member adapted for connection to a running-in string; a clutch nut assembly surrounding said body member and having a plurality of transversely aligned arcuate segments which together form a generally cylindrical structure, each segment having spaced upper and lower internal threads formed respectively in the left hand and the right hand directions; resilient means urging said segments together as a cylinder but permitting radial expansion thereof; and spaced upper and lower companion external threads on said body member engageable with respective threads on said segments by longitudinal movement without rotation and releasable from respective threads on said segments by rotation of said body member relative to said clutch nut assembly in one rotational direction, said lower threads on said segments and said body member being relatively coarse threads and asid upper threads on asid segments and said body member being relatively fine threads, said lower threads on said segments defining a through bore having a diameter which is at least as great as the root diameter of said upper threads.

2. In a well packer apparatus having settable packing and adapted to be releasably locked in both the running or retrieving and the set conditions in a well bore, the improvement comprising: a clutch nut assembly having a plurality of transversely aligned arcuate segments which together form a generally cylindrical structure, each segment having spaced upper and lower internal threads formed respectively in the left and the right hand directions, said lower threads being relatively coarse threads and said upper threads being relatively fine threads, said clutch nut assembly including resilient means for urging said segments together as a cylinder but permitting radial expansion thereof.

3. The apparatus of claim **2** wherein said upper and lower threads are formed on different diameter, said lower threads defining a through bore having a diameter which is at least as great as the root diameter of said upper threads.

References Cited

UNITED STATES PATENTS

2,831,542	4/1958	Lynes et al.	166—237 X
2,893,492	7/1959	Brown	166—119
3,279,542	10/1966	Brown	166—139
3,288,219	11/1966	Young et al.	166—134 X
3,311,173	3/1967	Henslee et al.	166—150
3,385,365	5/1968	Young	166—123 X
3,294,172	12/1966	Brown	166—139

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