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3,215,204

WHIPSTOCK ENGAGING AND RELEASING DEVICE

Filed Oct. 16, 1961

3 Sheets-Sheet 1

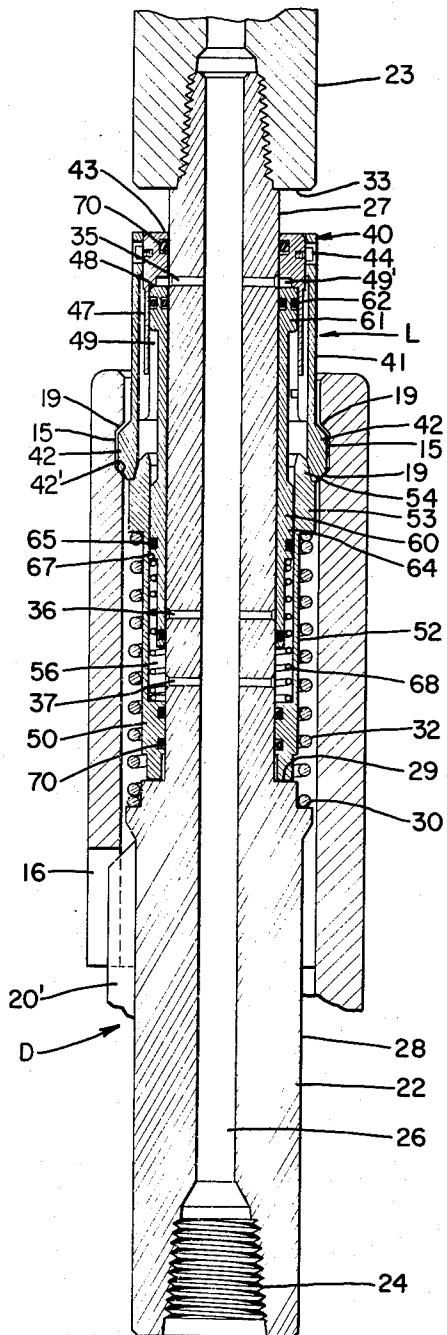


FIG. 2

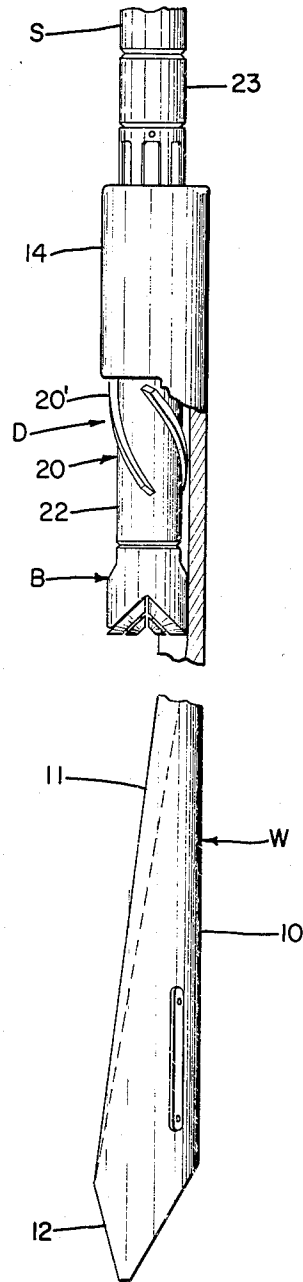


FIG. 1

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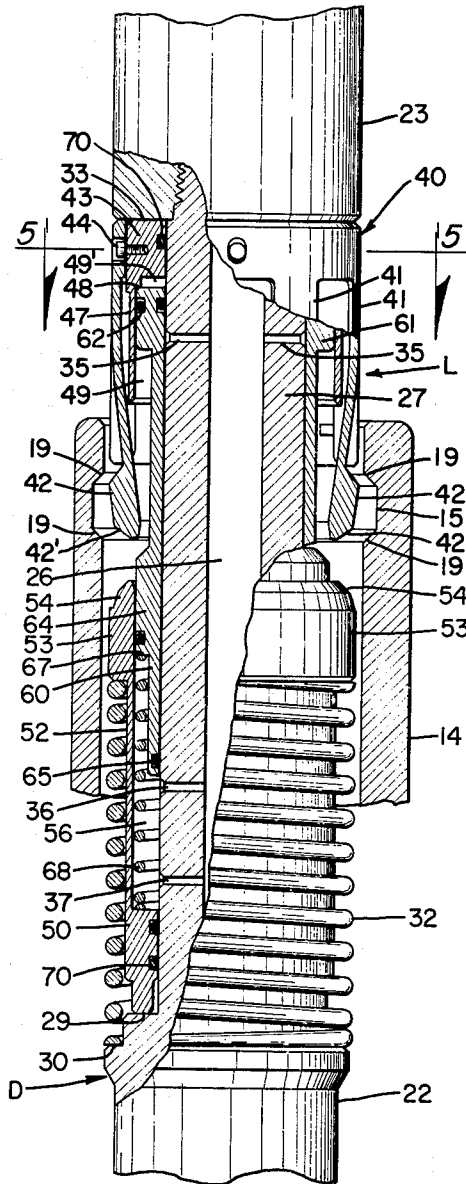
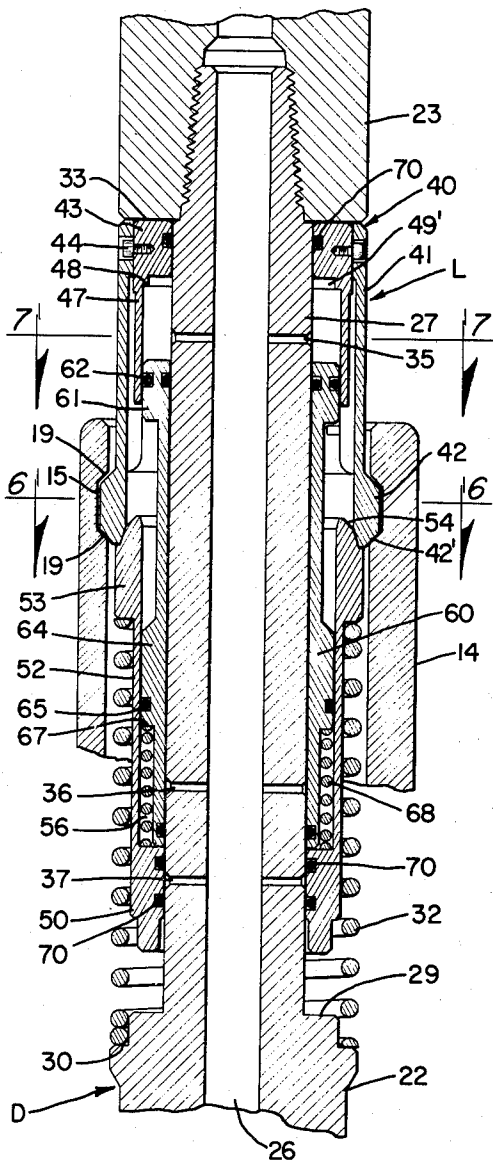
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3 Sheets-Sheet 2



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WHIPSTOCK ENGAGING AND RELEASING DEVICE

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11 Claims. (Cl. 166—117.5)

This invention relates generally to a novel and improved device for use in directional drilling operations in oil wells, and more particularly relates to a positive and effective means for controlling engagement and release between a whipstock and drill string.

Whipstocks are customarily employed in directional drilling operations for example to alter the course of drilling by serving as a guide to control the direction and angle of entry of the drill bit into the formation. Typically, the whipstock is connected to the lower end of the drill string just above the drill bit in traveling down through the bore hole, then at the desired point the whipstock is set in place and the drill string is selectively released for downward travel along the whipstock into the formation. Usually, conventional means for effecting engagement and release between the whipstock and drill string depend for their operation entirely upon the weight applied to the whipstock in order to release or break the drill string loose from connection with the whipstock for continued downward travel, and as a typical example shear pins are often employed as a means of interconnection between the members; however, it has been found very difficult to accurately gauge the shearing strength necessary to avoid accidentally shearing the pin loose from the whipstock going into the hole, without being unduly strong so that it is difficult if not impossible to shear the pin in high angle or sticky holes. In either event, misruns are often caused due to this problem and also it is impossible to apply any weight to the whipstock other than when the release is to be effected and this is a disadvantage where for example it is desired to drill out bridges or fill in the hole with the pump on and without releasing the whipstock. Accordingly, it is a principal object of the present invention to provide for a positive means for engagement between a whipstock and drill string which avoids accidental disconnection between the members, overcomes the above and a number of other disadvantages in conventional connecting devices, and which is further controllable from the surface for selective release only at the desired location in the bore hole.

It is another object of the present invention to provide for an improved device to serve as a means of interconnection between a whipstock and drill string which can be controlled in release and engagement from the surface without the use of a "GO-DEVIL" or wire line and which device can be reset into engaged relation after release, for example when it is desired to reorient the assembly.

It is a further object to provide for a positive and reliable means of interconnection between a drill string and whipstock and the like which cannot be accidentally released through the application of weight or pump pressure alone but which is dependent entirely upon the controlled and combined application of weight and hydraulic pressure in a certain manner in order to be effectively released; moreover, where the connecting device is so constructed and arranged so as to enable application of torque to the whipstock through the drill string combined with the application of weight thereto without bringing about the accidental release of the drill string from the whipstock.

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It is an additional object to make provision for an engagement and release device to establish positive interconnection between a pair of inner and outer concentric members through a mechanical locking arrangement which is controlled for selective release only through the combined application of weight and hydraulic pressure in prearranged sequence, whereby the entire device is easily oriented and can withstand the application of weight and fluid pressure without affecting the interconnection between the members.

The above and other objects, advantages and features of the present invention will become more readily understood from a consideration of the following detailed description taken together with the accompanying drawings, in which:

FIGURE 1 is an elevational view, partially in section, illustrating the entire whipstock assembly in connected relation with the lower end of a drill string;

FIGURE 2 is a vertical sectional view of a preferred form of whipstock engaging and releasing device in accordance with the present invention and illustrating the interrelation between parts when the whipstock is hanging from the drill string and being lowered through the bore hole and with pump pressure off;

FIGURE 3 is another sectional view of the preferred form of the present invention and illustrating in the interrelation between parts with pump pressure on and weight applied to the whipstock;

FIGURE 4 is another view, partially in section, and illustrating the interrelation between parts where weight is first applied to the whipstock, pump pressure is released and then subsequently applied to effect release between the whipstock and drill string;

FIGURE 5 is a cross-sectional view taken on line 5—5 of FIGURE 4;

FIGURE 6 is a cross-sectional view taken on line 6—6 of FIGURE 3; and

FIGURE 7 is a cross-sectional view taken on line 7—7 of FIGURE 3.

Referring in detail to the drawings, the over-all assembly of the present invention is broadly illustrated in FIGURE 1 where a conventional whipstock W is shown having an elongated body 10 formed with a tapered guide surface 11, pointed lower end 12 and an upper lift ring or annular head 14. Extending through the lift ring 14 for connection thereto is a conventional drill string S having a lower drill bit B, and the preferred form of locking device D is interposed between the lower end of the drill string and the drill bit.

As shown in FIGURES 2—5, the lift ring 14 of the whipstock is specially formed to cooperate with the member D to establish proper connection therebetween, and to this end the ring has formed in circumferential spaced relation around the upper part of its inner surface an annular dog-receiving groove 15 and also a lower open stabilizer slot 16. The configuration of the groove 15 is primarily such as to correspond with the size of the dogs or other connecting members employed on the device D to establish interconnection between the parts, and as further seen from FIGURE 6 the groove 15 is relatively deep with outwardly sloping top and bottom surfaces 19 as shown in FIGURE 2. On the other hand, the slot 16 extends completely through the thickness of the lift ring at its lower end and is designed to permit vertical sliding of a rib portion 20' of the stabilizer 20, at the lower end of the device D, into and out of engagement with the lift ring in a manner and for a purpose to be described. Other ribs are provided on the stabilizer but only one rib, 20', is provided with an extension to fit in slot 16 for alignment purposes.

Referring now in detail to the particular form of locking device D illustrated, its stated purpose is to

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provide a positive means of connection and release between the drill string and whipstock and where principally the device is so constructed and arranged as to be controllable from the surface and yet not be entirely dependent in connection and release either upon relative weight or hydraulic pressure alone, but instead will respond only to a particular combination of the two, especially in effecting release between the members. Accordingly, and to accomplish this purpose, the device D is broadly comprised of a sub body 22 which is shown as being interconnected to the lower end of the drill string through a suitable tool joint or adapter 23 and is also provided with a female threaded portion 24 at its lower end for connection to the drill bit. The sub body 22 carries at its upper end a locking assembly generally designated L which in cooperation with the sub body and lift ring provides in a unique manner the desired interconnection and release between the parts.

The sub body 22 is more specifically in the form of an elongated cylindrical portion having a central fluid passage 26 to conduct fluid under pressure passing through the drill string into the drill bit, and the sub body itself is defined by an upper cylindrical portion 27 of relatively small diameter and a lower cylindrical portion 28 of a relatively large diameter; upper and lower stepped, annular shoulders 29 and 30, respectively, are formed between the upper and lower cylindrical portions 27 and 28. The upper shoulder portion 29 serves as a lower limit of travel for the locking assembly, whereas the shoulder 30 defines an annular ledge to support the lower end of a compression spring member 32 in the locking assembly. In turn, it will be noted that the tool joint 23 is provided with a bottom annular surface 33 which defines the upper limit of travel for the locking assembly.

The upper cylindrical portion 27 is formed to present a smooth even exterior surface for mounting of the locking assembly thereon, and projecting laterally through the body of the cylindrical portion from the central fluid passage to the locking assembly are a series of three vertically spaced ports 35, 36 and 37 to supply fluid from the central fluid passage into the locking assembly. FIGURE 7 illustrates the arrangement of each series of ports and it will be noted that three ports are provided at each level in equal spaced relation to serve as a means of communication between the locking assembly and fluid passage.

The locking assembly L is disposed on the upper cylindrical portion to be freely slidable between the upper and lower limits of travel as best defined by surfaces 29 and 33 and this movement is governed by the direction of force of the whipstock in relation to the sub assembly. Specifically, the locking assembly is comprised of a locking sleeve 40 having downwardly depending, spring-loaded arms 41 with enlarged, outwardly projecting dogs 42 at the ends of the arms, the arms being biased inwardly and equally spaced in circumferential relation about the sleeve member. It will be noted that each dog 42 protrudes from the arm so as to be of a depth and configuration conforming to the respective slots 15 on the lift ring, and each is also provided with a lower inclined camming surface 42'; once engaged, the dogs act to prevent any relative shifting, vertically or laterally, between the lift ring and locking assembly.

The sleeve is mounted in outer concentric relation on an annular sleeve carrier member 43 through suitable connecting bolts 44, and the carrier 43 has circumferentially spaced slots 46 to accommodate the arm portions 41 in order to hold the flexible arms in proper spaced relation so that the dogs will be aligned with the slots 15 on the lift ring 14. The sleeve carrier 43 additionally includes a downwardly extending annular wall 47 which is arranged in spaced relation between the arms 41 and outer surface of the cylindrical portion 27 so as to define within the wall a chamber 49 which for example in the

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position of FIGURE 2 would be in communication with the upper series of ports 35. An inner ledge 48 is formed at the upper end of the wall 47 to provide a limited space 49' directly aligned with the ports 35 also when in the position shown in FIGURE 2.

The lower end of the locking assembly has a sleeve 50 serving as a locking or camming member which is free to slide along the exterior surface of the cylindrical portion 27, the sleeve including an upwardly extending wall portion 52 in spaced outer concentric relation to the cylindrical portion 27, an enlarged upper end portion 53 of annular configuration and an upwardly tapered extremity 54 which forms a cam movable into engagement with the camming surfaces 42' at the lower ends of the dogs 42. In this fashion, the lower sleeve portion 50 forms with the upwardly extending wall 52 a chamber 56 opposite the ports 36 and 37, and the latter ports are spaced relatively close together but at a considerable distance from the uppermost series of ports 35. Accordingly, upper and lower chambers 49 and 56 are respectively formed by the sleeve carrier 43 and lower sleeve 50, which chambers are preferably given different cross-sectional working areas, the upper chamber having a slightly greater differential area than the lower chamber for a purpose to be described.

The chambers 49 and 56 are effectively divided by means of a shuttle piston 60 of elongate generally tubular configuration and which is dimensioned to slide along the outer surface of the portion 27 between the upper end of the chamber 49 and lower end of the chamber 56. The shuttle piston includes at its upper end an enlarged piston area 61 which is slidable between the surfaces of the wall 47 and portion 27, and is limited in upward movement by the ledge 48. The piston is sealed as at 62 so as to be governed in movement by the force of fluid under pressure admitted into the upper chamber 49. In turn, an intermediate enlarged portion 64 is formed on the piston to slide between the inner surface of wall 52 and the portion 27 which is also sealed as at 65 to be controlled in movement by the introduction of fluid into the lower chamber 56. In addition, a shoulder 67 is formed at the lower end of the intermediate piston area 64 and a shuttle piston spring 68, a compression spring, is disposed between the shoulder 67 and top surface of the sleeve 50 so as to normally urge the piston 60 in an upward direction. Similarly, the compression spring 32 is positioned in outer concentric relation to the sleeve 50 for extension between the shoulder 30 and bottom surface of the cam member 53 and this spring will normally urge the entire lower sleeve assembly in an upward direction holding the dogs 42 in outward engaged relation in the slots 15. Also in order to completely seal the chambers, seals 70 are provided in grooves on the inner surface of the lower sleeve 50 and also on the inner surface of the sleeve carrier 43.

As a general consideration, it will be seen that the dogs are normally held in engaged relation with the slots 15 under the biasing of the cam 53. In the relation shown in FIGURE 2, the entire locking assembly is moved to its lower limit of travel against shoulder 29 when for example the whipstock is suspended from the drill string to apply a downward force on the dogs. In addition, when for instance the whipstock is lodged in the bore hole and applies an upward force on the dogs forcing the locking assembly to its upper limit of travel, as shown in FIGURE 3, the dogs will remain in engaged relation with the lift ring again due to the upward biasing of the piston and cam 53. Now, assuming fluid pressure is applied when the locking assembly is at its lower limit of travel as shown in FIGURE 2, the differential area between the upper and lower chambers 49 and 56 will be such as to cause the shuttle piston to move down, overcoming the bias of its spring 68 and closing the ports 36 and 37. Thus, in the absence of fluid pressure, whether the whipstock is hanging from the locking device or forc-

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ing upwardly thereon, it will have no effect on engagement or release between the members. Similarly, if hydraulic fluid is pumped through the fluid passage 26 when the locking device is in the position shown in FIGURE 2 it will cause downward movement of the shuttle piston to close the lower ports 36 and 37 due to the greater differential area across the top of piston area 61, but without releasing the dogs 42. Additionally, if, while pump pressure is on, the whipstock encounters any sort of impediment in the bore hole or in the event weight is intentionally applied thereto forcing the whipstock upwardly, the entire locking assembly will travel upwardly but the double force of the springs 32 and 68 will be sufficient to overcome any downward urging of the shuttle piston 60 under the influence of the hydraulic pressure; thus, the locking assembly still remains in engaged relation with the life ring.

In order to intentionally release the locking assembly to effect separation between the drill string and whipstock, it is necessary to undergo a certain sequence of operations initiated by forcing the locking assembly to the upper position against the tool joint, such as by the application of weight to the sub relative to the whipstock, followed by removal of pump pressure to permit the shuttle piston 60 to travel upwardly closing the upper series of ports 35, then applying pump pressure to enter initially through openings 36. At this point, the lower sleeve 50 will be forced downwardly away from the openings 37, overcoming the upward biasing of the single spring 32 so that the cam 53 will move away from engagement with the dogs, as illustrated in FIGURE 4, and the spring-loaded dogs will rapidly move out of engagement with the slots 15. The drill string is then immediately free to slide downwardly relative to the whipstock, for example to carry on directional drilling operations.

To assemble the device D at the surface for interconnection between the whipstock and drill string, the rib portion 20' acts as a means to establish proper alignment between the dogs 42 and groove 15 on the lift ring by locating the rib within the slot 16, and in this relation the lower sleeve 50 will force the dogs into engagement with the groove. In actual operation, when the whipstock is locked in place on the sub and lowered through the well without pump pressure, the lower sleeve and shuttle piston will remain in the "up" position again as in FIGURE 2. When the bridge or fill is encountered, the whipstock can be raised without pump pressure, then fluid under pressure can be ported through openings 35 and 37, but the differential area between the chambers will cause the shuttle piston to move down as described, closing the lower port. Of course, the lower sleeve 50 is held in place by the shoulder 29 and also the rib portion 20' will remain in the slot 16, and after the shuttle piston moves down, weight may then be applied to the whipstock through the drill string for example causing it to move to the position shown in FIGURE 3. Rotation of the drill string and device D will cause the whipstock also to rotate and through conventional downhole orienting equipment, dropped through the central fluid passage, the whipstock may be oriented in the proper direction for the drilling operation.

When desired to release the drill string for movement along the whipstock, and assuming the parts to be in the relative disposition shown in FIGURE 3, pump pressure is removed allowing the shuttle piston to move upwardly closing the upper port 35 and opening the port 36; then upon application of fluid pressure the lower sleeve 50 will be forced away from the shuttle piston, and the cam 53 will be forced out of engagement with the dogs whereupon the dogs will spring inwardly from engagement with the lift ring, under the biasing of their arms 41, and the drilling operation may then proceed. The double port arrangement 36 and 37 is preferably used due to the spaced relation between the lower sleeve

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50 and piston 60. At the lower limit of the locking assembly as shown in FIGURE 2 the ports 37 open into the chamber 56 principally to slow the downward movement of the piston 60 when pump pressure is on. Ports 37 will be closed at the upper limit, as shown in FIGURE 3, however, the ports 36 will open into the chamber 56 when the piston 61 moves upwardly in the absence of pressure and in this way will supply fluid to the lower chamber 56 to effect separation between the cam 53 and dogs.

If it is later necessary to reset the drill string in locked relation to the whipstock, it is merely necessary to pull the bit upwardly along the guide surface of the whipstock with the pump remaining on to keep the lower sleeve down. The single alignment rib 20' will reorient the sub to the whipstock and then when the rib is re-engaged, the pump is stopped to allow the dogs to relock and this may be tested by noting whether the bit will take weight. After engagement the tool may be reoriented if desired and again released in the manner described.

It will be appreciated from the foregoing that there has been devised a novel and highly effective form of locking device for use in locking inner and outer concentric members, and where such arrangement is of particular value in subsurface formations where locking and release can be controlled from the surface merely through the combined regulation of weight and hydraulic pressure. The particular sequence of steps necessary to effect release provides for greatly increased dependability in this type of operation together with the ability to reset the members in locked relation. In this connection, the locking device of the present invention would have utility in various applications similar to that of the specific type described and broadly where it is desired to establish the desired interconnection and release between a pair of concentric members, especially where the members must be so designed as to be either independently rotatable or selectively joined for rotation together. Accordingly, various changes and modifications may be made in the elements comprising the device of the present invention, as well as its particular application, without departing from the scope of the present invention as defined by the appended claims.

What is claimed is:

1. A locking device for releasably interconnecting a pair of inner and outer concentric members, the outer member including an annular connecting portion having dog-receiving means thereon, said device comprising a cylindrical body coupled in coaxial relation to the inner concentric member, the inner concentric member and said device having fluid conducting passages therein for conducting fluid under pressure, an annular locking assembly carried in slidable relation on said body, with limiting means on the body limiting slidable movement of the assembly between upper and lower limits of travel, said locking assembly comprising locking dogs disposed in outer spaced relation to the body, a cam member slidably mounted on said cylindrical body below said locking dogs being normally urged in a direction forcing said dogs radially and outwardly into engagement with the dog-receiving means, a first fluid chamber and port formed between said locking assembly and said body in communication with the fluid passage at one end of said locking assembly adjacent said dogs, and a second expandable fluid chamber and port formed between said locking assembly and said body in communication with the fluid passage at the opposite end of said locking assembly with the wall of said second chamber being connected to said cam member, piston means movable through said fluid chambers and including means normally urging said piston means toward the first fluid chamber, said piston means closing said first fluid port only when the assembly is at its upper limit of travel, and said cam member being movable downwardly away from engagement with said dogs under application of

fluid pressure into said second fluid chamber when the assembly is at its upper limit of travel thereby to release said dogs from engagement with said dog-receiving means.

2. A locking device according to claim 1, said body and outer concentric member having a complementary slot and rib portion aligned in relation to said dogs and dog-receiving slots to provide for alignment between said dogs and dog-receiving slots when said slot and rib portions are in engaged relation.

3. A locking device according to claim 1, said locking assembly being further characterized by a sleeve having downwardly depending spring-loaded arms thereon, said dogs being disposed at the lower ends of said arms, and a downwardly extending wall between said arms and said body defining with said body the first fluid chamber.

4. A locking device according to claim 3, said locking assembly further including a lower sleeve on said body having said cam members extending upwardly therefrom, and an upwardly extending wall between said cam members and the outer surface of said body forming with said body the second fluid chamber.

5. A locking device for releasably interconnecting a drill string and whipstock, the whipstock including an annular connecting portion having dog-receiving means thereon, said device comprising a cylindrical body coupled to the drill string, and the drill string and said device having fluid conducting passages therein for conducting fluid under pressure, an annular locking assembly carried in slidable relation on said body with limiting means on the body limiting slidable movement of the assembly between upper and lower limits of travel, said locking assembly comprising radially inwardly biased dogs in outer spaced relation to the body, a spring-biased cam member slidably mounted on said cylindrical body below said dogs being normally urged in a direction forcing said dogs radially and outwardly into engagement with the dog-receiving means, a first fluid chamber and port formed between said locking assembly and said body in communication with the fluid passage at one end of said locking assembly adjacent said dogs, and a second expandable fluid chamber and port formed between said locking assembly and said body in communication with the fluid passage at the opposite end of said locking assembly with the wall of said second chamber being connected to said cam member, piston means movable through said fluid chambers and including means normally urging said piston means toward the first fluid chamber, said piston means closing said first fluid port only when the assembly is at its upper limit of travel, and said cam member being movable downwardly away from engagement with said dogs under application of fluid pressure to said second fluid chamber when the assembly is at its upper limit of travel thereby to release said dogs from engagement with said dog-receiving means and provide for relative movement between the drill string and whipstock.

6. A locking device for releasably interconnecting a drill string and whipstock, the whipstock including an annular connecting portion having dog-receiving means thereon, said device comprising a cylindrical body coupled in coaxial relation to the drill string, the drill string and said device having fluid conducting passages therein for conducting fluid under pressure, an annular locking assembly carried in slidable relation on said body with limiting means on the body limiting slidable movement of the assembly between upper and lower limits of travel, said locking assembly comprising a sleeve having radially inwardly biased dogs disposed in outer spaced relation to the body, a lower sleeve slidably mounted on said body below said dogs having upwardly-biased cam means being normally urged in a direction forcing said dogs radially and outwardly into engagement with the dog-receiving means, a first fluid chamber and port formed between said body and said annular locking assembly in communication with the fluid passage at one end of said

locking assembly adjacent said dogs, and a second fluid chamber and port between said body and said lower sleeve in communication with the fluid passage at the opposite end of said locking assembly with the wall of said second chamber being connected to said cam means, the second fluid chamber having a smaller differential area than the first fluid chamber, a movable piston dividing said fluid chambers and including means normally urging said piston toward the first fluid chamber, said piston closing said first fluid port only when the assembly is at its upper limit of travel, and said cam means being movable downwardly away from engagement with said dogs under application of fluid pressure to said second fluid chamber when the assembly is at its upper limit of travel thereby to release said dogs from engagement with said dog-receiving means.

7. A locking device adapted for releasably interconnecting a drill string and whipstock, the whipstock having a top annular connecting portion including dog-receiving means thereon, said device comprising a body coupled to the lower end of the drill string including a fluid passage therein, a locking assembly carried on said body and being slidable thereon between upper and lower limits of movement, said locking assembly having a sleeve including a series of inwardly biased dogs engageable with the dog-receiving means on the whipstock, locking means carried on the body for movement between a first position holding said dogs in engagement with the dog-receiving means and a second position releasing said dogs and with means normally biasing said locking means to the first position, a movable piston interposed between said sleeve and locking means and defining therewith divided fluid chambers for the introduction of fluid under pressure, one chamber adjacent said sleeve having a greater differential area than the other chamber adjacent said locking means, said other chamber having its wall connected to said locking means, fluid ports between the fluid passage and the chambers for introduction of fluid under pressure thereto, and means biasing said movable piston to a first position in the one chamber when the locking assembly is at its lower limit of movement and to a second position closing said fluid port for the one chamber when the locking assembly is at its upper limit of movement, said piston being movable downwardly under the application of fluid pressure to said chambers when the locking assembly is at its lower limit of movement, and said locking means being movable downwardly to its second position releasing said dogs upon the application of fluid pressure to the other chamber when said locking assembly is at its upper limit of travel and said piston is in its second position closing said fluid port for the one chamber.

8. A locking device according to claim 7, the whipstock and said locking device having means therebetween cooperating to align said dogs opposite said dog-receiving means for interconnection of said locking device and whipstock.

9. A locking device according to claim 7, there being two series of upper and lower ports in vertical spaced relation communicating with said other chamber, the upper series of ports being closed by said piston when the locking assembly is at its lower limit of travel, and the lower series of ports being closed by said locking means when the locking assembly is at its upper limit of travel.

10. A whipstock engaging and release device for effecting selective engagement and release between a drill string and a whipstock, the whipstock having a top annular connecting portion including a dog-engaging groove on the inner surface thereof and a lower locating slot, said device comprising a sub coupled to the lower end of the drill string including a central fluid passage therein and a locating rib engageable with the locating slot, a locking assembly carried in outer concentric relation on said sub and being slidable thereon between upper and lower limits of movement, said locking assembly having

an upper sleeve providing a series of downwardly extending flexible dogs engageable with the slots on the whipstock to lock said sub and drill string against movement relative to the whipstock, a lower sleeve carried on the sub for movement between a first position holding said dogs in engagement with the slots and a second position releasing said dogs with means normally biasing said lower sleeve to the first position, a shuttle piston interposed between said sleeves and said sub having an annular rib defining upper and lower chambers for the introduction of fluid under pressure, the upper chamber having a greater differential area than the lower chamber, fluid ports between the central fluid passage and the upper and lower chambers for introduction of fluid under pressure into said chambers, and means biasing said piston to a position beneath the upper fluid port when the locking assembly is at its lower limit of movement and to a position closing said fluid port when the locking assembly is at its upper limit of movement, said piston being movable downwardly under the application of fluid pressure to said chambers when the locking assembly is at its lower limit of movement, and said lower sleeve being movable downwardly to its second position releasing said dogs upon the application of fluid pressure to said lower chamber when said locking assembly is at its upper limit of travel and said shuttle piston is in a position closing said upper fluid port.

11. Locking apparatus for releasably interlocking inner and outer hollow concentric members, said apparatus being mounted concentrically of said inner member and movable longitudinally thereof to a first or lower position and a second or upper position, said inner member having upper and lower ports communicating between its inner passage and said locking apparatus, said outer concentric member having locking means internally thereof, said locking apparatus comprising: interlocking means for cooperating with said locking means for interlocking

said members, said interlocking means being normally biased out of interlocking position; camming means operative in its upper position to cam said interlocking means into interlocking relation with said locking means and operative in its lower position to release said interlocking means from said interlocking relation, said camming means being normally biased toward its upper position and forming a wall of a first chamber between said locking apparatus and said inner member which is in communication with said lower ports; an upwardly biased shuttle piston mounted concentrically on said inner member with its lower end forming a wall of said first chamber and its upper end forming a wall of a second chamber between said locking apparatus and said inner member which is in communication with said upper ports, said second chamber having a larger differential working area movable under fluid pressure than said first chamber; said shuttle piston operative when said chambers are pressurized to move to a position through differential pressure in said chambers to block said lower ports and operative when said second chamber is unpressurized and said locking apparatus is in its second position to block said upper ports and clear said lower ports whereby said first chamber will be pressurized from pressure in the passage of said inner member to move said camming means to its second position to release said interlocking means.

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