Dec. 8, 1942. E. L. POTTS 2,304,119

KNUCKLE JOINT LOCK

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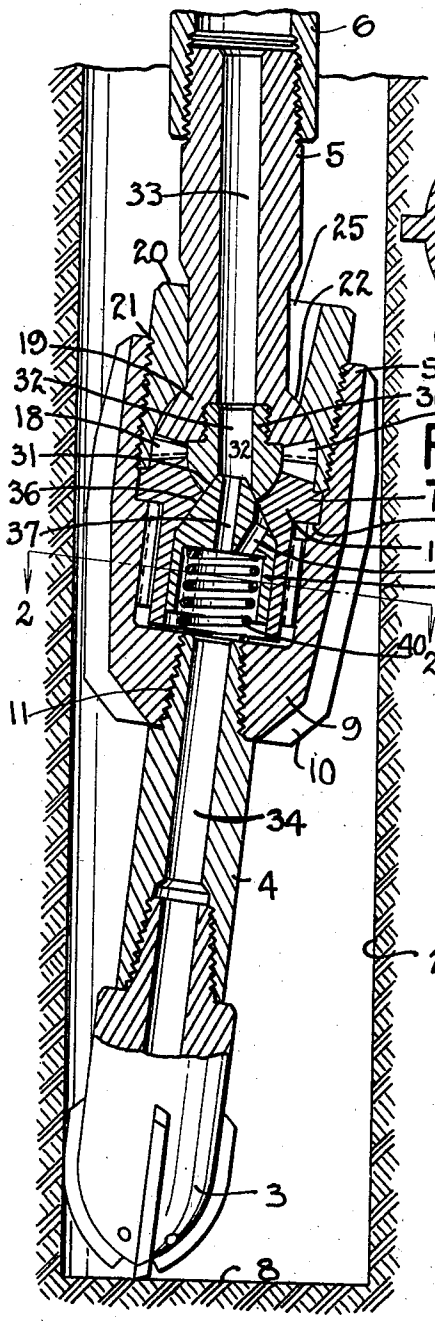


Fig. 1.

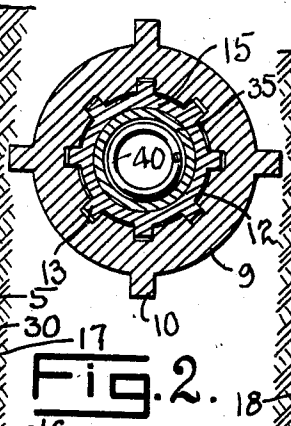


Fig. 2.

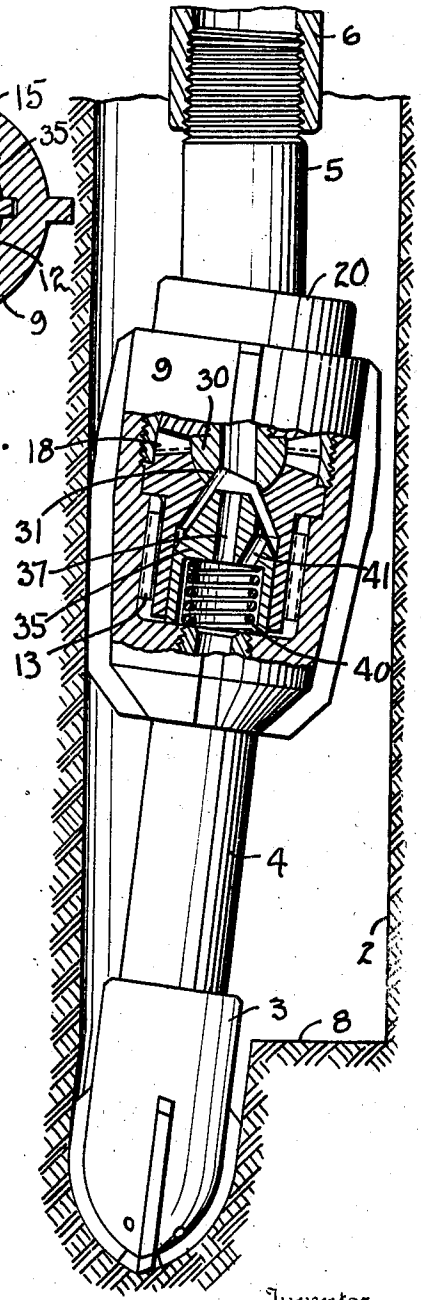


Fig. 3.

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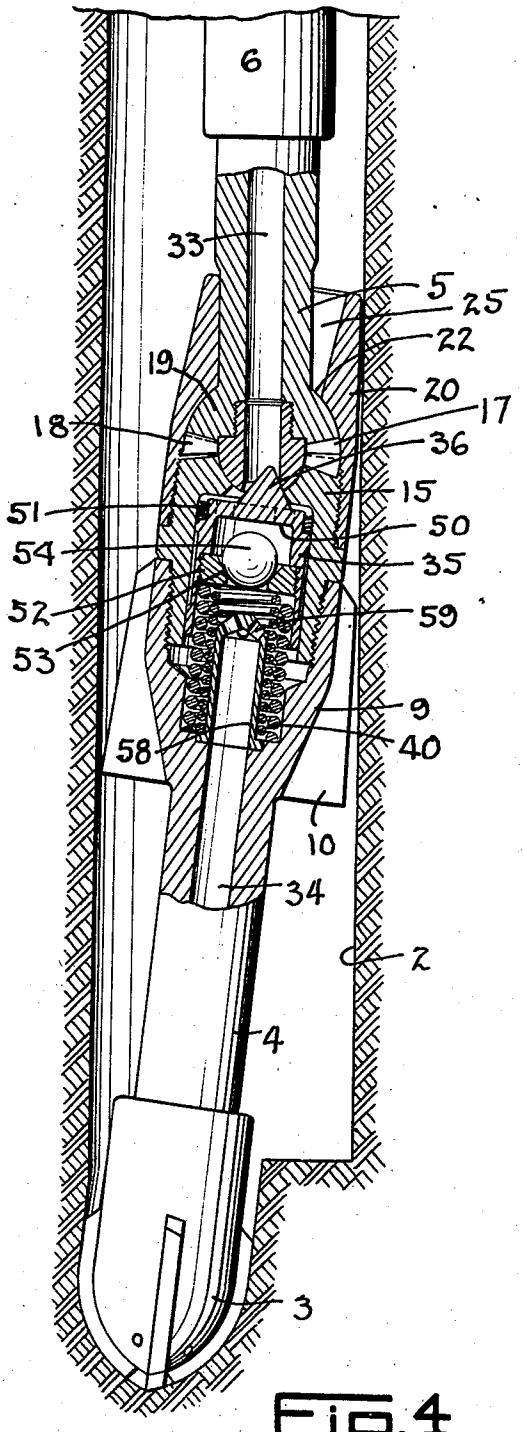


Fig. 4.

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Patented Dec. 8, 1942 2,304,119

UNITED STATES PATENT OFFICE

2,304,119

KNUCKLE JOINT LOCK

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Application October 30, 1939, Serial No. 301,977

5 Claims. (Cl. 255—1.6)

The invention relates to an improvement in deflecting tools of the type which may be used in drilling a well bore at an inclination with respect to the axis of the drill stem in the rotary method of drilling.

In well deflecting and straightening operations it is often necessary to incline the drill bit with respect to the drill stem so that the well bore may be deflected to provide an inclination with respect to the original well bore. To accomplish this various types of deflecting tools have been developed wherein a universal or knuckle joint, as they are generally known in the field, is used to connect the drill bit to the drill stem, so that the drill bit can be inclined and the drilling operation instituted and carried on with the bit in this inclined position. The knuckle joint must transmit rotation from the drill stem to the drill bit. The present invention adapts itself to this type of joint connection and provides for locking the connection is a predetermined inclined direction relative to the drill stem so that the drill bit will remain in this predetermined position until the drilling operation is to be instituted. This insures that the bit will arrive at the point where the deflection is to be made in the proper position and inclination and can be thereafter released.

It is one of the objects of the invention to provide a lock for knuckle joints which can be released by fluid pressure.

Another object is to provide a means and method of deflecting a well bore in a single operation whereby a survey to orient the tool, the deflecting operation to drill a full gage bore, and a subsequent survey can all be made without withdrawing the deflecting tool.

Another object of the invention is to provide a movable plunger which will release a knuckle joint lock in drill stems.

Another object of the invention is to provide an arrangement whereby a drill bit is locked in a predetermined inclined oriented position relative to the drill stem until such time as the bit has been spudded into the formation whereupon the lock can be released and the drilling operation carried on.

Another object of the invention is to provide a fluid pressure operated locking device for knuckle joints which will transmit a signal to the operator at the surface by a reduction in fluid pressure when the lock is released.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings wherein:

Fig. 1 is a vertical sectional view of the knuckle joint as it arrives in position at the bottom of the well bore with the bit locked in an inclined position.

Fig. 2 is a section taken on the line 2—2 of Fig. 1 and looking in the direction of the arrows.

Fig. 3 is a vertical sectional view of the bit after the drilling operation has progressed somewhat and shows the locking device released.

Fig. 4 is a vertical sectional view of another form of the same tool.

In Fig. 1 a well bore 2 is to be deflected at an angle with respect to its axis and to accomplish this a drill bit 3 connected to a sub 4 and a knuckle joint 5 has been lowered into the well bore by means of a drill stem 6.

It should be noted that the coupling 4 and the drill bit 3 are inclined with respect to the axis of the drill stem and that this inclination is permitted by virtue of the construction of the knuckle joint 5.

In deflecting well bores in the manner about to be described it is usually desirable to know the direction of the deflection so that it is desirable to arrange the drill bit 3 in a predetermined inclined position relative to the drill stem 6. The drill stem 6 can then be oriented into the hole so that the direction of inclination of the bit is known, or various types of surveying devices may be utilized in orienting the pipe in the hole after it has been lowered into position. Irrespective, however, of the method or apparatus which is used in determining the orientation of the drill bit it is desirable to retain the drill bit in a definite fixed position from the time it leaves the surface until the time it arrives upon the bottom 8 of the well bore 2 and such a construction is embodied in the structure of Fig. 1.

The knuckle joint 5 includes an outer housing 9 which may carry reamer blades 10 thereon. This housing is threaded at 11 to receive the sub 4 which carries the drill bit 3.

The inside of the housing 9 is hollow and carries a plurality of circumferentially arranged ribs 12 which have interfitting therewith the ribs 13 which are provided on a drive bushing 15, which is disposed inside of the hollow housing 9. This bushing 15 has an enlarged head 16 thereon which fits against a shoulder 15' inside of the housing.

The upper surface of the head 16 has a plural-

ity of spaced teeth or gear-like members 18 which interfit with similar members 17 on the lower end of the member 19 which forms part of the knuckle joint. In this manner the bushing 15 and the members 19 and 15 are non-rotatably connected but they can tilt angularly with respect to each other due to the length of the interfitting teeth or gears 18 and 19. As seen in Fig. 1, the teeth at the left of the center line will interfit while those on the right of the center line are drawn apart by the tilting of the bushing 15. A gland member 20 is threaded into the upper end of the housing and holds the bushing 15 in position. This gland 20 has a curved socket portion 21, which receives the curved ball area 22 on the member 19, so that a ball and socket or universal joint is in this manner provided which will permit limited tilting of the bushing 15 relative to the member 19, because of the fact that the opening 25 in the gland 20 is enlarged to permit it to tilt as seen in Fig. 1.

It seems obvious that the foregoing knuckle joint connection will transmit rotation while permitting tilting of the drill bit with respect to the drill stem.

As pointed out heretofore it is desirable to lock the drill bit 3 in a predetermined inclined direction prior to the time that it is lowered into the well bore. To accomplish this a seat member 30 is threaded into the lower end of the member 19 and this seat member carries an inclined seat 31, which is conical in construction and has the passage 32 therethrough. This passage merges with the passage 33 in the upper end of the knuckle joint so that a flow of flushing fluid may be pumped downwardly through the tool. A similar passage 34 passes to the drill bit.

Particular attention is directed to the inclination of the seat 31 with respect to the axis of the tool, as will be particularly noted from Figs. 1 and 3.

A plunger 35 is slidably arranged in an opening in the bushing 15 and this plunger has a tapered upper end 36 which is arranged to engage in the seat 31. This tapered end is symmetrical, however, with the axis of the plunger and the axis of the sub 4 and the bit 3. A coiled spring 40 is seated inside of the housing 9 and normally urges the plunger 35 upwardly into the seat 31. Thus the inherent resiliency of this spring forces the plunger onto its seat and would normally throw the drill bit off the inclination at which the seat 31 is inclined with respect to the drill stem. Of course, the bushing 30 may be arranged in the drill stem so that the seat is inclined at any desired angle and different types of bushings may be inserted so as to incline the bit at the desired angle for any particular set of circumstances.

The plunger 35 has a choke or small passage 37 therethrough which joins the passages 32 and 34. This passage 37 is of such a size that there may be some flow of fluid therethrough but it serves as a restriction for a full flow of fluid. An additional passage 41 extends in an inclined position through the plunger 35 and is open to a flow of circulation when the plunger is moved downwardly as is shown in Fig. 3.

In operation the parts will be assembled as shown in Fig. 1 and lowered into the well bore. The operator of course knows the inclination of the bit 3 with respect to the drill stem. The drill stem may be oriented in any desired manner one of which includes a magnet in the drill stem 6 adjacent the deflecting tool and a detector instrument to show the position of such magnet. Such instrument may be run into and out of the drill stem as desired. The tool is now dropped sharply so as to force the bit 3 into the bottom 8 of the well bore. This fixes the inclination of the bit with respect to the drill stem. During this operation drilling mud or flushing fluid is forced downwardly through the drill stem and through the choke passage 37 so that the operator knows that he has a predetermined pressure applied to this fluid to maintain a circulation. After the bit has been spudded in position the operator can increase the pump pressure so as to increase the rate of circulation and in this manner increase the pressure on the plunger 35. This increased pressure overcomes the spring 40 and moves the plunger down to the position shown in Fig. 3. This opens up the knuckle joint so that there may be a flow through both the passages 37 and 41. This combined flow is readily indicated to the operator by the sound of his pumps or a flow gauge so that he has a positive indication that the knuckle joint has been unlocked.

Inasmuch as the bit has been seated in the formation now that the joint is unlocked rotation may be started and the bit will penetrate the formation as seen in Fig. 3. The circulation of fluid maintains the bit in unlocked position. The reamer blades 10 are of substantially full gage so as to drill a deflected bore of the full diameter so that no subsequent reaming operation is necessary.

One of the particular advantages of this construction is that it insures the arrival of the bit on the well bottom in its proper inclined position. It permits the bit to be unlocked so that it may be used to deflect the well and then when the flow of flushing fluid is reduced the bit automatically locks itself again in its inclined position because the plunger 35 is moved upwardly by the spring 40 and a slight amount of rotation will cause the plunger to snap in against the seat 31 so that the bit is again locked. This construction is of advantage because it may be desirable to make more than one deflection from the same setting and it is only necessary to again spud the bit into the well bore, unlock it by fluid circulation, and continue the drilling at an additional inclination and furthermore there is no torque applied to the tool in unlatching it which might tend to turn the tool from its oriented position.

Attention is directed to the fact that the pressure against the inclined side of the plunger head 35 from the seat 31, as indicated in Fig. 1, is at a right angle with respect to the inclination of the head so that no amount of lateral pressure on the bit 3 could cause unlocking of the bit, and the bit can only be unlocked by an increase in fluid pressure.

Fig. 4 shows a slightly modified form of the deflecting tool wherein the parts are substantially the same as previously described except that the gland 20 is screwed onto the drive bushing 15 instead of into the housing 9 and the housing in turn is screwed onto the lower end of the drive bushing, which somewhat simplifies the manufacturing of the tool.

The plunger construction 35 is somewhat like that shown in Fig. 1 except that the tapered upper end 36 of the plunger does not have the passage 37 therethrough but such passage is provided at 50 in the head of the plunger to one side of the tapered portion 36. A packing ring

or sealing element 51 is provided around the plunger in the recess in the drive bushing.

In order to more accurately control the pressure and the opening and closing of the passage through the tool a support ring 52 has been affixed inside of the plunger and carries a seat 53 which is arranged to receive the ball check valve 54. Fluid under pressure passing downwardly through the tool and the openings 50 will hold the ball 54 upon its seat so as to close the passage completely. The plunger 35 and the support ring 52 are yieldably mounted upon a pair of coil springs 56 which project downwardly into the housing 9. The pressure of these springs normally urges the tapered portion 36 into the inclined seat 31 in the seat member 30.

Projecting upwardly from the inside of the housing 9 is a spindle 58 which has openings 59 in the top thereof. This spindle is of such an elevation that when the plunger 35 moves downwardly it will engage the ball check valve 54 and dislodge it from the seat 53. This opens up the tool to allow the circulation of liquid therethrough to wash the cuttings away from the bit. When the pressure is reduced and the plunger 35 moves upwardly the valve 54 will again seat and prevent circulation. In this manner a more definite signal is given to the operator because of the positive closing of the passage through the tool.

In the form of the invention in both Figs. 1 and 4 attention is directed to the relative size of the reamer blades 10 in that they are of substantially the same diameter as the well bore 2, so that as the drilling progresses the deflecting hole will be drilled to substantially full diameter or full-gage and in this manner the deflecting operation will result in a full sized bore without withdrawing the deflecting tool and inserting a regulation drilling bit. This is of material advantage in regard to cost and delay in the deflecting operation, because after deflection has been completed the ordinary bit may be moved into the bottom of the hole without performing a separate and independent reaming operation.

Broadly the invention contemplates a locking device for knuckle joints which can be released by fluid pressure and automatically re-locked by diminishing the pressure.

What is claimed is:

1. A knuckle joint for drill stems including a ball and socket connection, interfitting portions thereon to transmit rotation, a seat in said joint which is inclined with respect to the axis of the drill pipe, and movable means also in said joint to engage said seat and normally lock the joint in offset position, said last means including a spring pressed plunger, having a choke passage therethrough.

2. A knuckle joint for drill stems including a ball and socket connection, interfitting portions thereon to transmit rotation, a seat in said joint which is inclined with respect to the axis of the drill pipe, and movable means also in said joint to engage said seat and normally lock the joint in offset position, said last means including a spring pressed plunger, having a choke passage therethrough and an additional passage to be opened when said plunger is unseated.

3. A knuckle joint for drill stems including a ball and socket connection, interfitting portions thereon to transmit rotation, a seat in said joint which is inclined with respect to the axis of the drill pipe, and movable means also in said joint to engage said seat and normally lock the joint in offset position, said last means including a spring pressed plunger to be unseated by fluid pressure to release said bit.

4. A locking device for ball and socket member joints to lock the joint at a predetermined inclination including a plunger member carried by one member, an off center seat therefor carried by the other member, means to urge said plunger member against said seat to hold the joint in the off center position of the seat, and a fluid passage through said seat to be opened when said plunger is unseated.

5. A locking device for ball and socket member joints to lock the joint at a predetermined inclination including a plunger member carried by one member, an off center seat therefor carried by the other member, and means to urge said plunger member against said seat to hold the joint in the off center position of the seat, said plunger member being unseatable by fluid pressure passing the joint.

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