Oct. 12, 1954 G. E. BROWN 2,691,507

APPARATUS FOR ORIENTING WELL TOOLS WITHIN A WELL BORE

Filed Sept. 27, 1951

3 Sheets-Sheet 1

Fig. 1

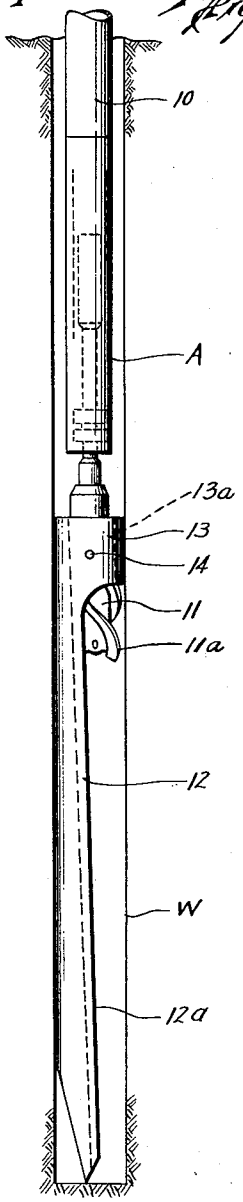


Fig. 2

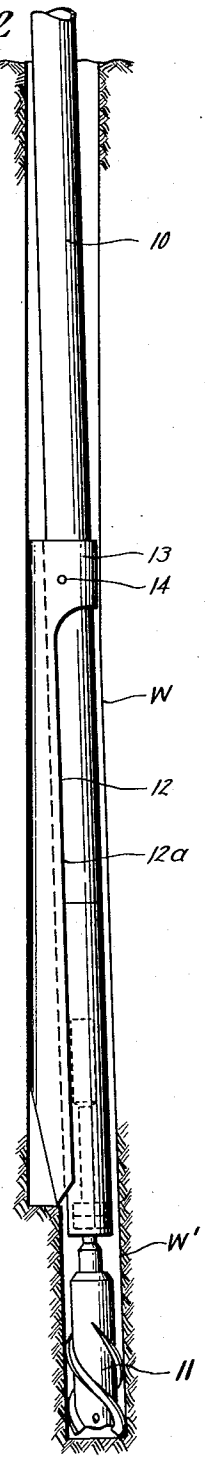
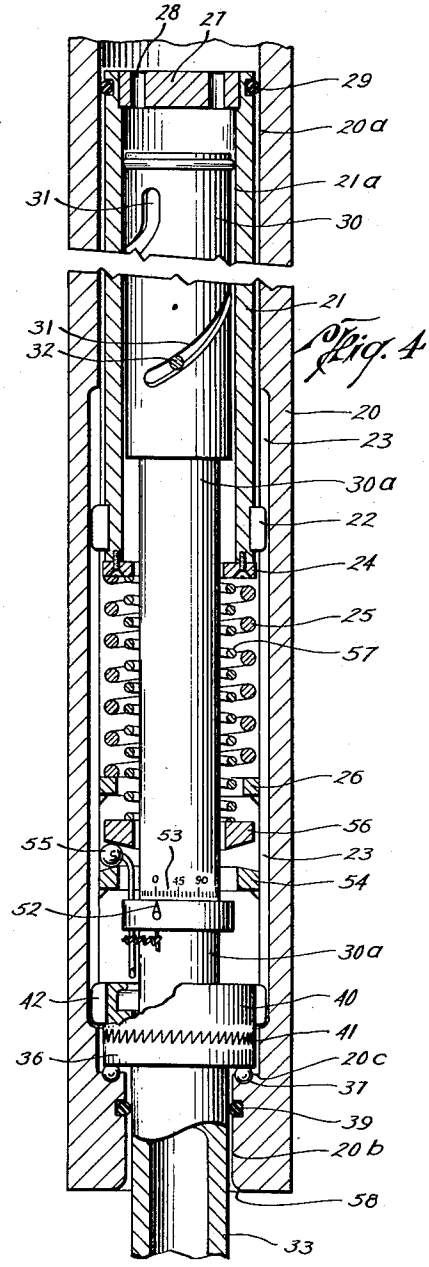


Fig. 4



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Fig. 3

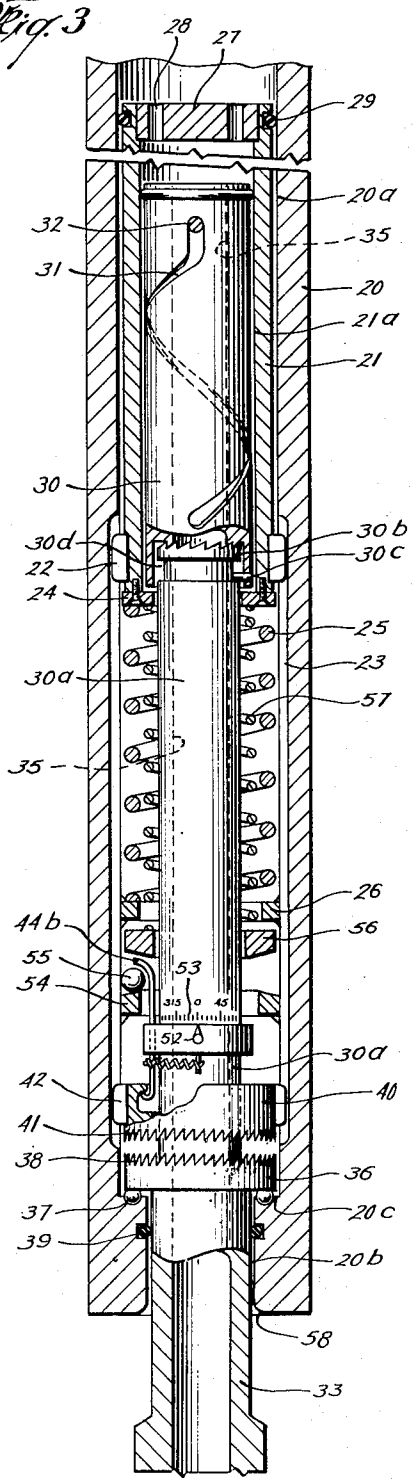
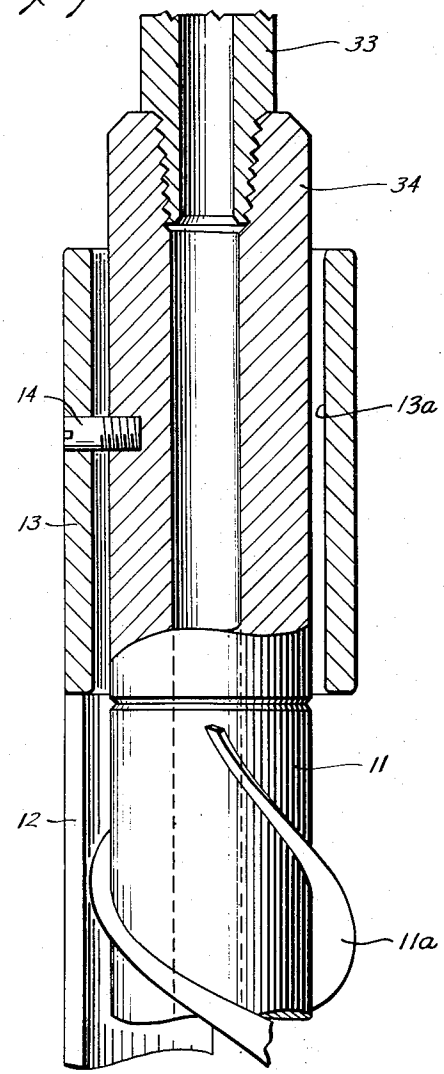


Fig. 3A



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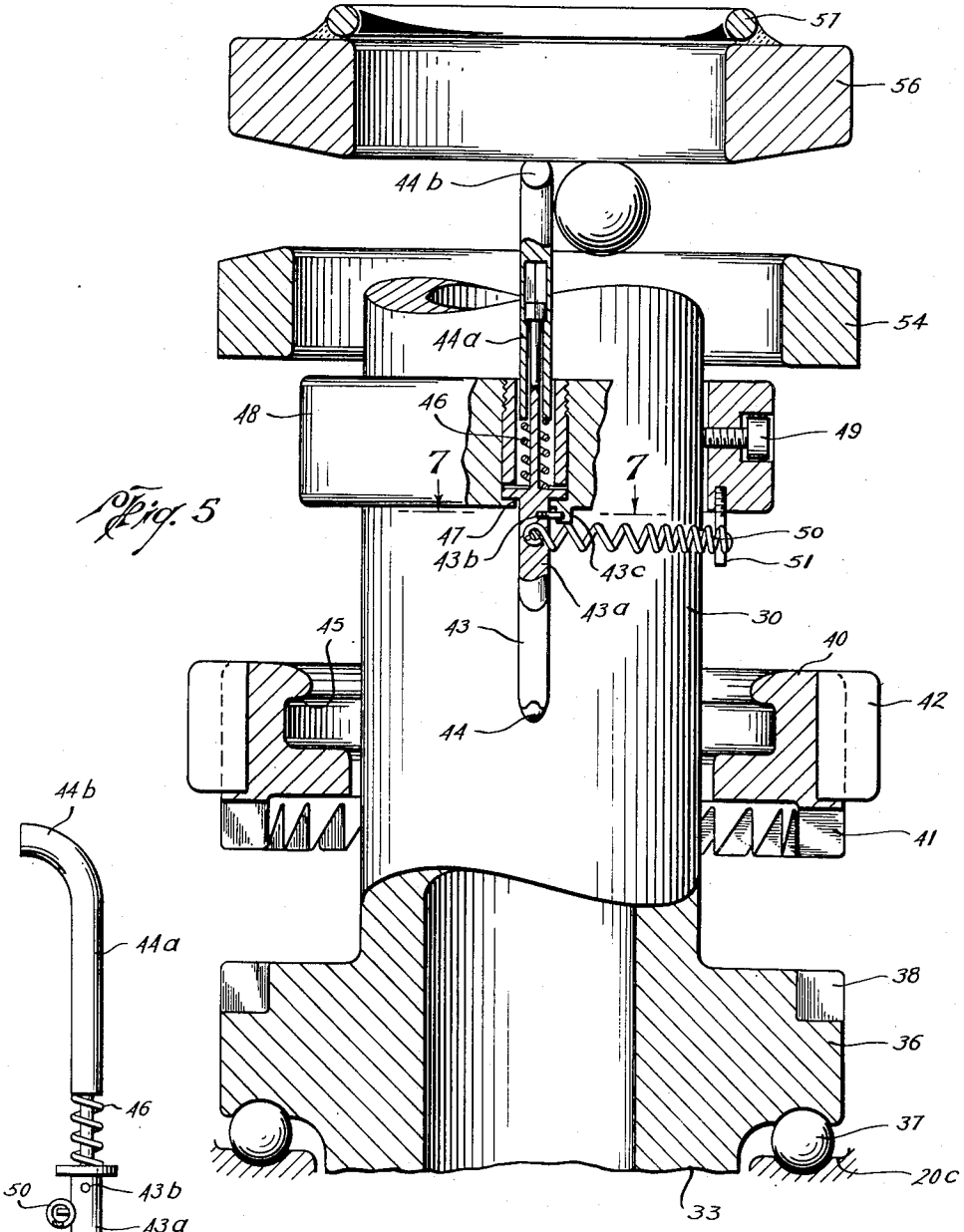


Fig. 5

Fig. 6



Fig. 7

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Patented Oct. 12, 1954

2,691,507

UNITED STATES PATENT OFFICE

2,691,507

APPARATUS FOR ORIENTING WELL TOOLS WITHIN A WELL BORE

Guy E. Brown, Fayetteville, Ark., assignor, by mesne assignments, to H. John Eastman, Denver, Colo.

Application September 27, 1951, Serial No. 248,558

11 Claims. (Cl. 255—1.6)

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This invention relates to new and useful improvements in apparatus for orienting well tools within a well bore.

This application is filed as an improvement on my application, Serial No. 127,729, filed November 16, 1949, Patent No. 2,567,507.

In my prior application above referred to an orienting apparatus is disclosed, wherein a compass unit controls the orientation of the whipstock, such compass unit providing a direct method for indicating azimuth. In wells which have some inclination an indirect method of indicating azimuth such as a gravity controlled weight or ball may be employed to control the orientation. The particular advantage of such indirect means for indicating orientation is in the fact that the unit may be made extremely rugged and can withstand much harder use than a compass element.

It is therefore one object of this invention to provide an orienting apparatus having all of the advantages of the apparatus disclosed in my prior application and wherein an indirect method of controlling the orientation is employed.

Another object is to provide an improved orienting apparatus for well tools wherein the pressure of the normally circulated or pumped drilling fluid is utilized to effect the orientation and to lock the tool in its oriented position.

Still another object is to provide an orienting apparatus of the character described, wherein the well tool is rotatably mounted on the lower portion of the drill pipe and wherein pressure-actuated means having connection with the tool functions to rotate the tool into oriented position, together with a gravity-actuated orienting means and a connecting means controlled by said actuating means for rotatably connecting the well tool to the drill pipe when the tool reaches its predetermined oriented position; said gravity-controlled actuating means controlling the operation of the connecting means in an automatic manner whereby orientation of the tool is accomplished in a minimum time and with substantially no additional work on the part of the operator.

A still further object is to provide an orienting apparatus which is extremely rugged in construction so that it can withstand the shock and vibration of drilling which occurs subsequent to the orienting operation and which has means permitting a circulation of drilling fluid to the drill bit.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

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The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is an elevation of an orienting apparatus, constructed in accordance with the invention, connected in the drill string and illustrating the deflecting tool to be oriented as a whipstock, with the assembly being shown in a well bore prior to orientation of the tool,

Figure 2 is a similar view illustrating a drilling operation being performed off of the face of the deflecting tool,

Figure 3 is a transverse vertical sectional view of the apparatus prior to operation thereof,

Figure 3A is a continuation of Figure 3 illustrating the connection between the apparatus and the whipstock,

Figure 4 is a view similar to Figure 3 showing the position of the parts after the apparatus has been operated,

Figure 5 is an enlarged view partly in section and partly in elevation of the orienting means,

Figure 6 is a detail view of the latching rod, and

Figure 7 is a horizontal cross-sectional view taken on the line 7—7 of Figure 5.

In the drawings the numeral 10 designates a drill pipe which is adapted to be connected with the usual drill bit 11 by means of the improved orienting apparatus A. A whipstock 12 having the usual collar 13 encircles the bit shank and is connected thereto by means of a frangible shear pin 14. The bore 13a of the whipstock collar is of less diameter than the outside diameter of the bit blades 11a of the bit and therefore when the pin 14 has been sheared the bit may be utilized to retrieve the whipstock. The particular whipstock and bit arrangement forms no part of the present invention but is the usual construction employed in the directional drilling of well bores.

The assembly which includes the drill pipe 10, orienting apparatus A, drill bit 11 and whipstock 12 is adapted to be lowered within a well bore W within which a directional drilling operation is to be carried out. Upon reaching the position at which the whipstock 12 is to be set the lower end of the whipstock is engaged with the bottom of the well bore or with a plug (not shown) within said bore, and after the whipstock face 12a is properly oriented, as will be explained, the pin 14 is sheared to disconnect the bit and drill pipe from the whipstock. It is then possible to carry out a directional drilling

operation as illustrated in Figure 2 with the drill bit 11 being guided downwardly along the inclined face 12a of the whipstock. After the directional drilling operation which forms an angular or deflected bore W' is complete the drill pipe 10 and bit 11 are pulled upwardly and the engagement of the bit with the whipstock collar functions to retrieve the whipstock as the drill pipe is withdrawn from the bore.

The foregoing is usual directional drilling practice and the present invention resides in the apparatus A which is adapted to effect an orientation or proper positioning of the whipstock 12 whereby the face of said whipstock is disposed in a desired compass or azimuthal position so that drilling in a desired direction may be subsequently carried out.

The apparatus A is clearly shown in Figures 3 to 5 and includes a main tubular body or casing 20 which has its upper end connected with the lower end of the drill pipe 10. The main body is formed with an axial bore 20a and a tubular actuating piston 21 is slidably mounted within said bore. The piston is non-rotatable within the body and is held against rotation therein by keys 22 secured to the piston and movable within longitudinally extending keyways or grooves 23 formed in the wall of the bore of the body 20. A bearing ring 24 is secured to the under side of the piston 21 and the piston is normally urged toward an upper position by a relatively strong coil spring 25 which is confined between the bearing ring 24 and a supporting ring 26 attached to the wall of the bore of the body. The upper end of the tubular actuating piston is closed by a cap or closure 27 which has a plurality of openings 28 extending therethrough. A suitable annular seal ring 29 is mounted on the upper end of the piston and seals off between said piston and the bore 20a of the body 20.

The tubular piston 21 is adapted to impart a rotation to an operating mandrel 30 which is disposed within the bore 21a of said piston. The external surface of the mandrel 30 is formed with a spiral or helical groove 31 and an actuating pin 32 mounted on the inner wall of the piston 21 engages within this groove. When the piston is in its raised position the actuating pin is nearer the upper end of the spiral or helical groove of the mandrel 30, as illustrated in Figure 3, and upon downward movement of the piston within the bore of the body 20, the coaction between the actuating pin 32 and the spiral groove 31 imparts a rotation to the mandrel 30. The lower end of the mandrel has an operating connection with a tubular shank or drive rod 30a through a ratchet connection 30b, whereby rotation of the mandrel in one direction imparts rotation to the rod; rotation of the parts in an opposite direction allows slippage therebetween. The mandrel is rotatably connected to the drive rod 30a and has a limited movement longitudinally thereof through a pin 30c and groove 30d connection.

The lower end of the drive rod 30a projects outwardly through a counterbore 20b provided at the lower end of the main body or casing 20 and is formed with a connecting pin 33 whereby the drive rod and mandrel may be connected to a sub 34. The drill bit 11 is threaded into the lower end of the sub and said sub is connected by the shear pin 14 to the collar 13 of the whipstock 12. The mandrel and drive rod are formed with a bore 35 which extends entirely therethrough, and this bore communicates with the bore of the sub and the bore of the bit to direct drilling fluid downwardly to the bit.

Secured to the drive rod 30 just above the counterbore 20b of the casing is a gear ring 36, and this gear ring is mounted upon bearings 37 supported upon the shoulder 20c which is formed between the bore 20a and counterbore 20b of the body or casing 20. The gear ring 36 is formed with ratchet type gear teeth 38 which are directed upwardly. A suitable packing ring 39 mounted in the counterbore packs off around the extending end of the mandrel 30 to prevent extraneous matter and fluid from entering the interior of the casing 20.

It will be seen that the operating mandrel and drive rod 30 having the gear ring attached thereto are rotatably mounted by means of the bearings 37 with respect to the outer casing or body 20. Thus, when the tubular piston 21 is moved downwardly by the application of pump pressure to its upper end, the coaction between the pin 32 and the spiral groove 31 will impart a rotation to the mandrel, drive rod and sub 34 connected to the lower end of the rod. Since the sub is connected by the shear pin to the whipstock, it will be evident that as the mandrel and rod are rotated due to the piston 21 moving downwardly within the body, the whipstock 12 will undergo a similar rotation.

For halting the rotation of the whipstock when it reaches its desired azimuthal position and also for connecting the drill bit to the casing 20 and therefore to the drill pipe, an orienting and locking assembly is mounted in the lower portion of the body or casing 20 above the gear ring 36. This assembly includes a clutch collar 40 having downwardly directed ratchet type teeth 41, which teeth are adapted to engage the upwardly directed teeth of the gear ring 36. The clutch collar is keyed against rotation within the casing by means of keys 42 which engage the keyways or grooves 23, and thus, the clutch collar is non-rotatable within the casing. Obviously, when the clutch collar is in engagement with the gear ring a rotation of the casing will be imparted through the clutch collar and gear ring to the rod 30a through the sub 34 and to the drill bit.

The clutch collar 40 is normally latched in a raised position with respect to the gear ring 36 by means of a latch rod 43. As is clearly shown in Figure 5, the latch rod includes an inwardly directed hook 44 at its lower end which is engageable beneath an overhanging annular shoulder 45 formed within the upper end of the clutch collar. The latch rod is constructed of a lower section 43a which telescopes an upper section 44a; the connection between the sections is such that said sections do not rotate with respect to each other and said sections are normally urged apart by a coil spring 46. The lower portion of the lower section 43 is preferably formed of flat spring steel (Fig. 6) whereby the hook 44 may be swung in a lateral plane. The latch rod is rotatably supported within an opening 47 provided in an adjustable orienting ring 48, which ring is adapted to be secured in various positions upon the drive rod 30a by a suitable set screw 49. A spring 50 having one end connected to the latch rod and its opposite end connected to a stationary pin 51 on the ring 48 tends to rotate the latch rod in a direction which will maintain the hook 44 beneath the overhanging shoulder. Rotation of the rod by the spring is limited by a stop pin 43b engaging a stop lug 43c

on the ring and this properly locates the hook **44** beneath the shoulder **45**. The orienting ring **48** has an indicator **52** thereon which is movable with respect to a degree scale **53** formed upon the drive rod **30**.

A ball race or supporting ring **54** is secured to the wall of the bore of the main body or casing **20** and a gravity controlled ball **55** is mounted on this ring. The upper end of the upper section **44***a* of the latch rod is curved as indicated at **44***b* and normally this curved portion overhangs the ball **55**. A locking ring **56** is suspended above the ball by an extension spring **57** which has its lower end welded to the ring **56** and its upper end welded to the bearing ring **24** on the lower end of the piston. The spring **57** is constantly tending to contract so that the lock ring **56** is suspended in a floating position above the orienting ball **55**.

In the operation of the orienting assembly it is evident that the orienting ball **55** will seek the low side of the hole. The operator, by means of a previous survey, is aware of the compass direction of the low side of the hole, and therefore knows that the ball will seek such direction. As the piston **21** is actuated to impart a rotation to the mandrel and to the whipstock, such downward movement of the piston will cause the locking ring **56** to move downwardly into contact with the ball **55** and upon so engaging the ball the ball will be locked in its oriented position due to the clamping action between the ring **56** and the supporting raceway **54**. Such downward movement of the locking ring will also depress the upper section **44***a* of the latch rod **43** to move the curved portion **44***b* of said section into the same horizontal plane as the ball. Thus, as the mandrel continues to rotate the latch rod **44** will revolve therewith, and when the upper curved end **44***b* of said latch rod strikes the clamped ball **55**, the rod **43** will be rotated on its axis so as to move the hook **44** at its lower end from beneath the overhanging shoulder **45** of the clutch collar. When this occurs, the clutch collar moves downwardly by its own weight so as to engage its teeth with the teeth of the gear ring. This sets up a direct driving connection from the main casing through the clutch collar and gear ring to the drill bit, and at the same time halts further rotation of the whipstock. Such rotation is halted because the fluid pressure acting upon the piston and tending to rotate the mandrel is insufficient to rotate the drill pipe string. It is evident that by adjusting the position of the latch rod **43** circumferentially with respect to the ball **55**, it is possible to locate the whipstock in any desired direction at the time that the clutch collar is released.

The operation of the apparatus is believed obvious from the foregoing. The parts are assembled as illustrated in Figure 3 with the orienting ring **48** being adjusted relative to the scale **53** so as to locate the latch rod **43** the proper number of degrees circumferentially from the low side of the hole. The position of the latch rod in a longitudinal plane is noted with respect to the face of the whipstock, and thereafter the assembly is lowered into the well bore. When the whipstock reaches the bottom of the hole or the plug on which it is to be set, the orienting ball **55** falls to the low side of the hole. Thereafter, pump pressure is applied through the drill pipe to the upper end of the actuating piston **21** and downward movement of this piston results

in a rotation of the whipstock due to the coaction of the pin **32** and spiral slot **31** which rotates the mandrel to which the whipstock is connected.

As the piston moves downwardly to impart rotation to the mandrel and whipstock, the spring **57** functions to move the lock ring **56** downwardly into contact with the orienting ball **55** to frictionally lock this ball in its oriented position. At the same time, the lock ring depresses the upper end of the latch rod to move the curved end of said rod into position for contact with the clamped orienting ball. It is noted that during these operations the hook **44** at the lower end of the latch rod is engaged beneath the overhanging shoulder **45** and is held so by the coil spring **50**.

As the mandrel continues to rotate the whipstock moves into the desired position at the time that the latch rod **43** engages the clamped orienting ball **55**, and at this instant a rotation is imparted to the rod which disengages its hook **44** from the shoulder **45** of the clutch collar, thereby releasing the clutch collar and permitting its teeth **41** to engage the teeth **38** of the gear ring. When this occurs rotation of the mandrel is halted because the clutch collar connects the mandrel through the gear ring directly to the casing **20**; said casing is attached to the drill pipe which is stationary at this time and thus, further rotation of the whipstock is halted. Thereafter, it is only necessary to impose the weight of the drill pipe upon the shear pin **14** which may be accomplished through the underside of the raceway ring **54** engaging the clutch collar which transmits a force through the clutch collar and gear ring to the sub **34**. After the pin is sheared, the drill pipe may be rotated and rotation is imparted to the drill bit through the casing **20**, clutch collar **40** and gear ring **36**, and drilling off of the whipstock face may be carried out.

It will be evident that the device is exceptionally rugged in construction and may therefore withstand the shock and vibration occasioned by the drilling operation. The apparatus is also positive in its operation since the orienting ball is gravity-controlled and will always seek the low side of the hole. After assuming orienting position the ball is clamped in such position to be sure that it will remain for engagement by the latch rod which releases the clutch collar. The mounting of the latch rod within the orienting collar **48** makes it possible to release the clutch collar at any point spaced circumferentially around from the low side of the bore, and thus the whipstock may be oriented in any desired direction.

The apparatus is arranged so that it may be reset any number of times in the event that the operator is not satisfied that the first setting is correct. Assuming the apparatus to be in the position shown in Figure 3 prior to the setting thereof, the pump pressure is applied to rotate the mandrel and drive rod. As has been explained, this results in a release of the clutch collar **40** which drops into engagement with the gear ring to lock the whipstock against further rotation. If it is now desired to reset the apparatus and again orient the whipstock, the drill pipe and casing **20** attached thereto are lowered until the whipstock strikes the bottom of the bore which renders the gear ring **36** and its attached connecting drive rod **30***a* stationary. Further lowering of the drill pipe causes the casing **20**

to move downwardly a slight distance with respect to the gear ring, and this causes the follower ring 56 to engage the upper end of the latch to fully telescope the parts and to thereafter depress both sections of the latch downwardly to re-engage the hook beneath the overhanging shoulder 45 of the clutch collar 40. Then by lifting the drill pipe and casing 20 the clutch collar will be lifted and returned to the position shown in Figure 3. Thereafter, pump pressure can again be applied to the piston which has been returned to its original position by release of pump pressure to again operate the apparatus and re-orient the whipstock. It is therefore possible to reset and re-orient the whipstock any desired number of times before shearing of the shear pin 14. The ratchet connection 30b between the operating mandrel 30 and the drive rod 30a which carries the gear ring 36 is provided for the purpose of allowing the actuating pin 32 to return to its upper position when pump pressure is released and without imparting a reverse rotation to the drive rod 30a. It will be evident that after the piston has been moved downwardly, as illustrated in Figure 4, a release of pump pressure will cause the spring 25 to return the piston to its upper position. Upon such return the coaction between the actuating pin 32 and spiral slot 31 will rotate the mandrel 30 in a reverse direction; such reverse rotation of the mandrel may occur through the ratchet without imparting such reverse rotation to the connecting drive rod 30a and its attached parts.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made, within the scope of the appended claims, without departing from the spirit of the invention.

Having described the invention, I claim:

1. A well tool orienting apparatus including, a tubular body adapted to be connected with a drill pipe, a mandrel rotatably mounted within the body and connected with the well tool to be oriented, pressure-actuated means within the body having an operative connection with the mandrel for imparting rotation to the mandrel and well tool, connecting means interposed between the mandrel and body for connecting the mandrel to the body for preventing further rotation of the mandrel with respect to the body, a latch means mounted on the mandrel and rotatable therewith and having releasable engagement with the connecting means for normally maintaining said connecting means in its unconnected position, and a gravity-controlled orienting means within the body and disposed in the path of rotation of a portion of the latch means whereby when said latch means is rotated due to rotation of the mandrel said latch means engages the orienting means and is operated to actuate the connecting means and thereby connect the mandrel to the body.

2. An orienting apparatus for well tools including, a tubular body adapted to be connected with a drill pipe and lowered therewith within a well bore, a mandrel rotatably mounted within the body and connected with the well tool to be oriented, a piston slidably mounted within the bore of the body and movable downwardly therein by the pressure of a fluid circulated downwardly through the drill pipe and body, co-acting means on the piston and mandrel for converting the downward movement of the piston into a rotative motion, whereby the mandrel is rotated to rotate the well tool, a toothed gear ring on the mandrel, a complementary gear collar keyed within the body and adapted when engaged with the ring to connect the mandrel and body together to prevent further independent rotative movement of the mandrel relative to the collar, a latch means mounted on the mandrel and engaging the collar for normally holding the collar out of engagement with the ring, actuation of said latch means releasing the collar for engagement with the ring, and a gravity-controlled element mounted in the housing and disposed in the path of a portion of the latch means and engageable by said latch means, said engagement actuating the latch means to release the collar for engagement with the ring when the mandrel has rotated to move said latch means into contact with said gravity-controlled element.

3. An orienting apparatus as set forth in claim 2, wherein the latch means is mounted in a collar which is adjustably mounted on the mandrel whereby the latch means may be disposed at any desired point circumferentially about the mandrel.

4. An orienting apparatus for well tools including, a tubular body adapted to be connected with a drill pipe and lowered therewith within a well bore, a mandrel rotatably mounted within the body and connected with the well tool to be oriented, a piston slidably mounted within the bore of the body and movable downwardly therein by the pressure of a fluid circulated downwardly through the drill pipe and body, co-acting means on the piston and mandrel for converting the downward movement of the piston into a rotative motion, whereby the mandrel is rotated to rotate the well tool, normally disengaged means on the mandrel and tubular body for connecting said mandrel and body to prevent relative rotation of the mandrel with respect to the body, an orienting assembly carried by the mandrel for controlling the engagement of the normally disengaged means, said assembly including an annular raceway within the body, a gravity-controlled ball on said raceway, and means connected with and actuated by the piston adapted to engage the ball for frictionally locking said ball in an oriented position.

5. An orienting apparatus for well tools including, a tubular body adapted to be connected with a drill pipe and lowered therewith within a well bore, a mandrel rotatably mounted within the body and connected with the well tool to be oriented, a piston slidably mounted within the bore of the body and movable downwardly therein by the pressure of a fluid circulated downwardly through the drill pipe and body, co-acting means on the piston and mandrel for converting the downward movement of the piston into a rotative motion, whereby the mandrel is rotated to rotate the well tool, a toothed gear ring on the mandrel, a complementary gear collar keyed within the body and adapted when engaged with the ring to connect the mandrel and body together to prevent further independent rotative movement of the mandrel relative to the collar, a latch mounted on the mandrel and normally engaged with the gear collar for holding the gear collar out of engagement with the gear ring, an annular raceway within the body adjacent the upper portion of the latch, a gravity-controlled element movable on said

raceway for assuming an oriented position when the apparatus is lowered within a well bore, and means for locking the gravity controlled orienting element in its oriented position whereby rotation of the mandrel moves the latch into contact with the locked orienting element to actuate the latch and release the gear collar for engagement with the gear ring.

6. An orienting apparatus as set forth in claim 5, wherein the latch is mounted within a collar which is adjustably secured to the mandrel whereby the circumferential position of the collar on the mandrel may be varied.

7. As a sub-combination in an orienting apparatus, an orienting and operating assembly comprising a mandrel, a latch rod mounted on said mandrel and rotatable therewith, a gravity-controlled orienting element movable in an annular path around the mandrel and adapted to seek an oriented position in accordance with inclination, and means for locking the element in its oriented position, the upper end of the latch rod being disposed in the path of the locked element whereby rotation of the mandrel moves said latch rod into contact with said orienting element to actuate said rod.

8. The sub-combination as set forth in claim 7, wherein the latch rod is mounted within a collar which is adjustably mounted upon the mandrel whereby the circumferential position of the latch rod on said mandrel may be varied.

9. A well tool orienting apparatus as set forth in claim 2, together with means actuated by manipulation of the drill pipe for releasing the connecting means between the mandrel and the body, whereby a subsequent duplicate operation of the apparatus may be carried out.

10. A well tool orienting apparatus including, a tubular body adapted to be connected with a drill pipe, a mandrel rotatably mounted within the body and connected with the well tool to be oriented, pressure-actuated means within the body having an operative connection with the mandrel for imparting rotation to the mandrel and well tool, an orienting assembly within the body and including a gravity-controlled element, a clutch member surrounding the mandrel and keyed within the body, a gear member secured to the mandrel and engageable by the clutch member to set up a direct connection between the body and mandrel, said clutch member being normally disengaged from said gear member, and a latch means carried by the mandrel and engageable with the clutch member for holding said member in a position disengaged from the gear member, said latch means having a portion thereof adapted to be engaged by the gravity-controlled element to effect a release of the latch means to unlatch the clutch member and cause its engagement with the gear member.

11. An orienting apparatus for well tools including, a tubular body adapted to be connected with a drill pipe and lowered therewith within a well bore, a mandrel rotatably mounted within the body and connected with the well tool to be oriented, a piston slidably mounted within the bore of the body and movable downwardly therein by the pressure of a fluid circulated downwardly through the drill pipe and body, co-acting means on the piston and mandrel for converting the downward movement of the piston into a rotative motion, whereby the mandrel is rotated to rotate the well tool, a gear member secured to the mandrel, a clutch member keyed to the bore of the body and surrounding the mandrel, said clutch member being normally disengaged from the gear member, a latch means mounted on the mandrel and latching the clutch member in a position disengaged from the gear member, and a gravity-controlled member movable within the housing and adapted to engage the latch means to operate said latch means and thereby release the clutch member for engagement with the gear member to set up a direct connection between the body and the mandrel.

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