Jan. 14, 1958 J. S. BECK 2,819,878

SUSPENSION DRILLING DEVICE AND JAR

Filed Sept. 24, 1956

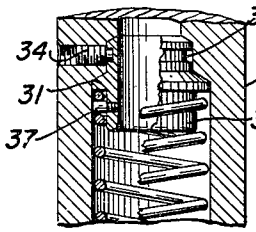


FIG. 8.

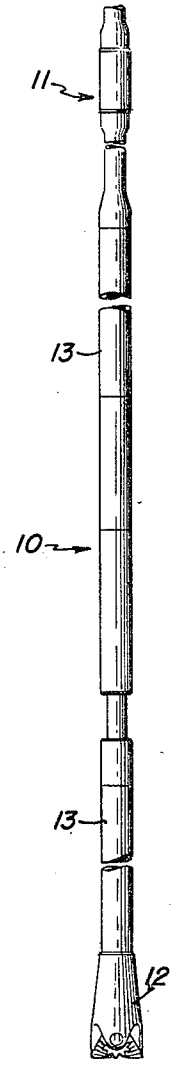


FIG. 1.

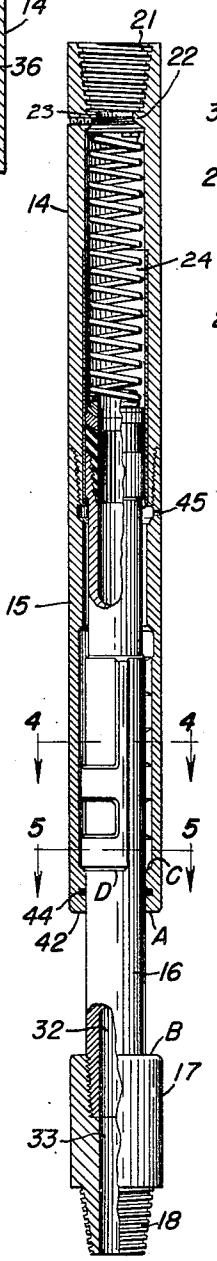


FIG. 2.

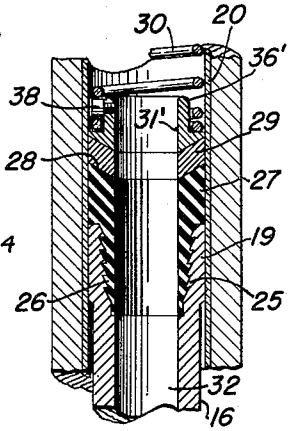


FIG. 7.

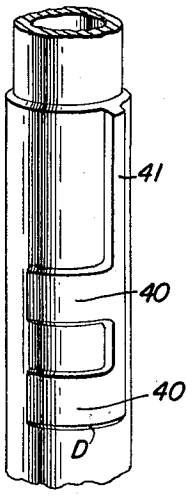


FIG. 3.

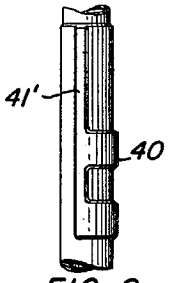


FIG. 9.

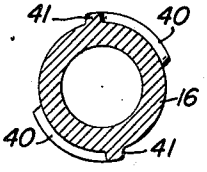


FIG. 4.

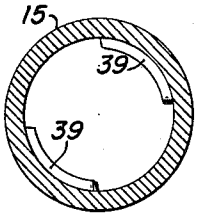


FIG. 5.

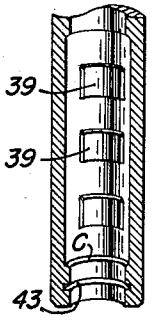


FIG. 6.

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SUSPENSION DRILLING DEVICE AND JAR

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5 Claims. (Cl. 255—28)

This invention relates to oil well drilling and has reference to a device to be connected in a drilling string.

In rotary drilling, and particularly in deep wells, it is difficult to maintain the optimum weight on the drill bit. Too much weight lends to eccentric drilling, and not enough weight impairs efficiency of the drilling operation. Moreover, eccentric drilling creates critical angles in the bore hole and the resulting binding and increased resistance does not give a true reading on the weight indicator at the earth's surface. Also, eccentric drill strings impair true readings in survey instruments lowered therein.

The present invention is directed to a telescoping device for connection in a drill string above a drill bit, with the result that the weight of the pipe above the device does not affect the weight load on the bit. The desired weight or load on the bit is accomplished by adding or removing lengths of drill pipe and collars below the device; thus, a selected constant, or nearly constant, load is applied and carried to the bit at all times regardless of the length and weight of the drill pipe suspended thereabove, or regardless of the frictional resistance of the pipe above the device with the side of the bore hole. Thus, the drill string below the device has a plumb bob action for eliminating or reducing eccentric holes, and thus prevents buckling of the string as occurs in conventional drilling when too much load is placed on the bit.

The invention has advantages or objects other than reducing or eliminating eccentric holes. For example, by reason of its construction, the invention may also be used as a jar if the drill string or bit becomes stuck, as by reason of earth formation bridging, the device may be used to jar either up or down, or may be used for bumping.

Another object of the invention is the elimination of bounce and the reduction of vibration in the drill pipe and drill collars above the device, thus, extending the life of the drill pipe, kelly bushings, swivels, and generally reducing the wear on the entire drilling apparatus.

Another object of the invention is to provide an effective seal arrangement in a suspension drilling device, and which seal prevents drilling fluid from passing directly into the device's locking or clutch mechanism, thus, reducing wear due to the abrasive qualities of the drilling fluid.

In addition to the foregoing, the suspension drilling device comprising the present invention reduces the number of bits used during any one drilling operation since excess weight is not applied to the bits; fewer round trips are made to replace the bits; drilling time is reduced by reason of more efficient operation of the rotary bits; and few bits, if any will break in the hole, thus reducing or eliminating fishing operations.

The invention also eliminates wash pipes, such as those used in rotary jars, thus allowing survey instruments to be lowered through the device and at the same time

providing a larger orifice through the device for reducing mud friction.

In the accompanying drawing of an exemplary form of the invention:

Figure 1 is a broken elevation of a length of drill string having a rotary bit on the lower end thereof, and shows the present invention installed in the string above the bit.

Figure 2 is an enlarged vertical sectional and broken elevational view of a preferred embodiment of the invention.

Figure 3 is a broken perspective view of the mandrel of the present device showing one of the longitudinal ribs and its laterally projecting keys forming a part of the lock mechanism.

Figure 4 is a transverse sectional view of the mandrel taken on line 4—4 of Figure 2.

Figure 5 is a transverse sectional view of the tubular body taken on line 5—5 of Figure 2.

Figure 6 is a vertical sectional and perspective view of the lower end of the tubular body.

Figure 7 is an enlarged vertical sectional view of the cylinder comprising the upper portion of the device and showing a sealing construction therein for directing drilling fluid through the mandrel and preventing the fluid from cutting the referred to locking mechanism.

Figure 8 is a view similar to Figure 7, but showing the upper end of the seal actuating spring and means securing the same in the upper end of the cylinder.

Figure 9 is a broken elevation of a modified form of the invention in which the keys on the mandrel are arranged in an opposite direction from those shown in Figure 3.

As illustrated in Figure 1, the present suspension device 10 is connected in a drill string 11 including a rotary rock bit 12 and any required number of drill collars 13. The present suspension drilling device 10 is connected between drill collars 13 and as will become apparent the weight or load on the bit 12 is primarily determined by the number of drill collars connected beneath the suspension drilling device.

As illustrated in detail in Figure 2, the present device 10 is comprised of a tubular body including an upper tubular cylinder portion 14, and a lower tubular member or body 15 threadedly connected therebeneath, a tubular mandrel 16 slidably disposed within said cylinder 14 and body 15 and extending downwardly beneath the latter, together with a sub 17 threadedly connected with the lower end of the mandrel 16. The sub 17 is of a larger diameter than the mandrel 16, and which sub is provided with tapered threads 18 on its lower end for connection with the drill collars 13 and bit 12 therebeneath.

The upper end of the mandrel 16 is enlarged, at 19, for sliding contact with the inner surface of a tubular liner 20 of wear resistant material in the upper tubular cylinder 14, and the upper end of the cylinder 14 is provided with threads 21 for connection with a drill collar 13 thereabove. Immediately below the threads 21, the cylinder 14 is of reduced diameter to provide an inwardly formed shoulder 22, which construction provides an opening 23 for the passage of drilling fluid therethrough. Immediately below the shoulder 22 the inside diameter of the cylinder 14 is enlarged to provide a hydraulic chamber 24 for effecting a shock absorber action to be referred to in the following description of operation.

The enlarged diameter 19 of the upper end of the mandrel 16 is provided with internal buttress threads 25 for engaging and gripping corresponding threads 26 on the lower end of a sealing member in the form of a piston type cylindrical seal 27, the diameter of which above the mandrel 16 is in sliding contact with the tubular liner 20. The upper end 28 of the seal 27 is cupped

to receive a correspondingly shaped circular hollow retainer **29**. The retainer **29** is held in its described position by means of a coiled compression spring **30** having spring adapters **31**, **31'** on each end thereof. The upper adapter **31** engages the inwardly formed shoulder **22** of the cylinder **14** whereas the lower adapter **31'** bears against the upper surface of the retainer **29**. The opening **23** in the shoulder **22**, the diameter of the spring, the axial openings **32** and **33** through tubular mandrel **16** and sub **17** are of sufficient diameters to permit survey tools to be lowered therethrough. A predetermined calculated spring load expands the upper end of the resilient seal **27**, by constant pressure on the cupped retainer **29**, so that an effective seal is maintained even though there is no downward surge of fluid pressure at the time. As the outer surface of the seal **27** wears, the spring load laterally expands the seal and thus in effect causes the seal to replace itself. The upper spring adapter **31** is secured in place by means of a screw **34** in one side of the cylinder **14** and through the inwardly formed shoulder **22**, where the inner end of the screw engages a circular groove **35** in the upper part of said retainer. The lower end of the retainer is of reduced diameter, as at **36**, to receive the upper end of the spring **30** thereon, and another set screw **37** is secured in the side of the reduced diameter **36** between coils of the spring for securing the latter in place. Similarly, the lower retainer **31'** is provided with a reduced diameter, as at **36'**, for receiving the lower end of the spring **30**, and a screw **38** is provided in the referred to reduced diameter between the coils of the spring. Thus, in the event that the cylinder **14** and the body **15** should become separated, the spring **30** may be raised by means of the upper drill string **11** to the earth's surface and thus permit unimpaired fishing of the lower portion of the device.

The lower inside diameter of the tubular body **15** is enlarged where the same is provided with vertical rows of integral spaced bosses **39** for engaging corresponding lateral keys **40** integral with and on opposite sides of the mandrel **16**. The keys **40** are integrally joined with vertical longitudinal ribs **41** on corresponding sides thereof, and as shown in Figures 2 and 3, these ribs being on the right side of said keys. It is to be noted that in the illustrated form of the invention that there are two keys **40** on each side of the mandrel **16** and that the vertical rib **41** extends thereabove. It is also to be noted that in the illustrated form of the invention there are three bosses **39** in each vertical row, and that there are two keys **41** on each side of the mandrel for coaction therewith, and that the bosses **39** are spaced from the lower end of the tubular body so that the lowermost key **40** may be positioned therebeneath. Also, with reference to the lower end of the tubular body **15**, it will be noted that the same is inwardly shouldered, as at **42**, to provide sliding contact with the surface of the mandrel **16**, and as shown in Figures 2 and 6 there is a circular groove **43** therein for receiving an O-ring seal **44**.

The shouldered lower end **42** of the body **15** serves as a hammer A for striking the upper end or shoulder of the sub **17**, the latter being hereinafter referred to as the anvil B, during certain phases of the operation to be defined. Similarly, but for a different operation, the upper surface of the shoulder **42** serves as a hammer C for striking the lower edges of the two lowermost keys **40** on the mandrel **16**, and which key edges are hereinafter referred to as anvil D.

Another, but important detail of construction, is a port **45** in the wall of the tubular body **15** for equalizing pressures inside and outside of the tubular mandrel **16**. The port **45** also accommodates fluid displacement within the body **15** during certain phases of the operation.

Operation

After the surface pipe has been set, the suspension drilling tool **10** is connected in the drill stem string **11** between upper and lower drill collars **13** and above the bit **12** as shown in Figure 1. The string **11** is then lowered in the hole with the suspension drilling tool **10** in its extended position until the bit **12** reaches the bottom of the hole. The string **11** is then raised sufficiently to take a reading of the total weight of the drill string assembly, after which the string is again lowered until the bit touches bottom and another reading is taken on the weight indicator for establishing the difference in total weight and the weight of the upper portion of the string above the suspension drilling device. Thus, the difference in weight is the weight or load on the drill bit. If this weight or pressure is not correct the drill string **11** may be removed from the hole and collars **13** added or removed as required. The drill string **11** is picked up off of the bottom and the pumps are started, thus circulating drilling fluid downwardly through the string. After the fluid returns through the bore hole around the string **11**, another weight indication is taken to determine the difference between the initial weight and the weight after fluid is circulated. Thus, the actual operating load on the bit **12** is determined, including effective added weight by reason of the piston-like action of the seal **27** within the hydraulic chamber **24**. Initially, the suspension drilling device **10** is in its contracted position, after which the brake on the draw works is locked and the drill string **11** is rotated causing the bit **12** to turn and drill in the bottom of the hole. It is to be understood that during the drilling operation the vertical ribs **41** on the mandrel **16** make sliding contact with the bosses **39** within the body **15** for transmitting torque from the upper drill string to the lower drill string and the bit **12**. Continued rotation of the drill string allows the bit **12** to feed into the earth until the mandrel **16** of the device **10** becomes fully extended, at which time the weight indicator at the earth's surface registers an increase in weight. The fully extended position of the mandrel **16** is determined by contact of the lower keys **40** with the inwardly formed shoulder **42** in the bottom of the tool body **15**. The upper portion of the drill stem **11** is then lowered until the body **15** contacts the shoulder of the sub **17**, and after which the described drilling operation is repeated.

If any part of the drill string **11** becomes stuck, either while drilling, going into the hole, or coming out, then the suspension device **10** may be used for determinging whether the upper length or the lower length of the drill string is stuck, and for freeing the drill string. If the string cannot be freely raised and lowered, the indication is that the upper portion of the string is stuck above the suspension drilling tool **10** and conventional methods are required to free the same. On the other hand, if the upper portion of the drill string moves up and down freely within the limits of the stroke of the device, then the indication is that the drill string is stuck below the suspension device. The driller then has the option of using the tool for spudding (working up and down as in cable tool drilling) to free the lower length of drill string, or the use of the suspension device as a delayed action jar. It is pointed out that spudding is not preferred since such operation tends to buckle, corkscrew, dog leg or otherwise damage the expensive drill string.

In delayed jarring, and if coming out of the hole when the string is stuck below the suspension device, the upper length of drill string is turned to the right several turns until considerable torque is applied to the lower length of the string. The upper length of the string is then slowly released, thus releasing the torque and slight resulting momentum of which causes the lower bosses **39** in the body **15** to engage the keys on the mandrel **16**, after which the drill string is lowered and thus weighted or loaded, creating potential energy for the jarring operation to follow. The upper string is then rotated to the right,

disengaging the bosses 39 of the keys 40, and after which the upper string is suddenly released causing the hammer A on the lower end of the body 15 to strike the anvil B on the upper end of the sub 17. Such operation may be repeated, but during the downward jarring operation it is preferred that the bit 12 is not on the bottom of the hole.

In order to jar upwardly, the upper portion of the string is lowered until the suspension device 10 is in its contracted position and the lower portion of the string is then rotated to the right causing the bosses 39 to slidably engage the vertical ribs 41. The upper string is turned to the right creating a torque in said upper string, after the upper string is then gently released and the slight resulting momentum will cause the upper bosses 39 to engage the keys 40. The upper length of drill string is then raised and stretched a calculated length and while in a raised and stretched position the upper string is again rotated to the right causing the bosses 39 to disengage the keys 40 and cause the hammer C (shoulder 42) to strike the anvil D (lower edge of the keys 40). As before, this operation may be repeated until the lower string is dislodged.

It is to be understood that the jarring effect, either up or down, may be varied by engagement of the keys 40 between the upper and lower bosses 39.

During the drilling operation described in the foregoing, the equalizing port 45 in the side of the tubular body 15 admits and discharges drilling fluid from the bore hole as the piston-like seal 27 moves up and down. By reason of the diameter of the hydraulic chamber 24 being larger than the diameter of the axial passage 32 through the mandrel 16, a downward piston-like action is imparted to the mandrel and the drill string therebelow. As the drilling fluid is forced under pressure downwardly through the drill string, such force tends to spread the cupped shaped upper end of the seal 27, but it is pointed out that the described arrangement and action of the preloaded spring 30 on the seal creates an effective seal at all times, even when the fluid is not passing therethrough.

An alternate form of the invention

An alternate or modified form of the invention includes all of the parts described in connection with the suspension drilling tool 10 with the exception of the location of the vertical ribs 41' which are to the left of the keys 40 as viewed in Figure 9 instead of on the right as illustrated in Figures 2 and 3. This form of the invention has, for its primary object, the provision of a device which is installed in a drill string and is for furnishing a readily available jar during drilling, reaming, formation testing, and directional drilling operations. The device is capable of jarring in either direction, and by reason of the seal 27 and its component parts, the device may be left in the string without damage to the device by reason of the washing action under pressure of abrasive drilling fluids as described in connection with the suspension drilling device 10. Depending upon the type of operation to be performed, drill collars 13 may or may not be employed, and in certain operations, such as reaming, a drill bit, such as 12, may not be used. The device is always locked during drilling and other operations by reason of the described location of the vertical ribs 41' on the left side of the keys 40. As before, if the drill string 11 becomes stuck, it can be determined whether or not the free point is above or below the device by releasing the torque, thereby releasing the bosses 39 from the keys 40, and attempting to move the drill string up or down. If, while the device is thus unlocked, the drill string moves the length of the stroke of the device, then the free point is above the device. On the other hand, if the drill string does not move freely, then the free point is below the device and conventional methods may be employed for dislodging or retrieving drill string. Where the drill string is stuck below the device, and after the torque has been released, and in order to strike up, the device is contracted by downward movement of the upper drill string until the lower end of the body 15 touches the shoulder on the sub 17, and after which the upper string is rotated to the right to cause the bosses 39 in the body 15 to engage the keys 40 on the mandrel 16. The upper length of the drill string is then stretched a calculated distance, after which torque is applied and released with the result that the bosses 39 disengage the keys 40 and thereby suddenly release the body 15 and cause the hammer C to strike the anvil D for dislodging the stuck pipe or tools. The operation may be repeated as required.

In order to strike down, the upper portion of the string is raised to its extended or partially extended position, as may be desired, and the upper string 11 is again rotated to the right to lock the device and to apply torque as before. A downward pressure is then applied to the upper string and the torque is released, causing the bosses 39 to release the keys 40 and allow the hammer A to strike the anvil B. The operation may be repeated as required to dislodge the lower length of the drill string and tools thereon.

The invention is not limited to the exemplary construction herein shown and described, but may be made in various ways within the scope of the appended claims.

What is claimed is:

1. In combination with a drill string, a tubular body connected at one end thereof with a section of said drill string, a tubular mandrel slidably mounted in said body and extensible therefrom, the extending end of said mandrel being connected with a second section of said drill string, means limiting the longitudinal movement of said mandrel and means limiting rotation of said mandrel within said body, said tubular body providing a hydraulic chamber, a sealing member comprising a cylindrical member of resilient compressible material in said chamber adjacent the upper end of said mandrel, said sealing member having an axial passage therethrough providing communication between the tubular body and the bore of the mandrel, and means urging said sealing member into engagement with the upper end of the mandrel and into sealing engagement with the wall of the tubular body.

2. The combination as set forth in claim 1, wherein the diameter of the axial passage through the sealing member is of substantially the same diameter as the diameter of the bore of the mandrel.

3. The combination as set forth in claim 1, wherein the means urging said sealing member into engagement with the wall of said tubular body comprises a coiled compression spring mounted in said tubular body and arranged to bear against the sealing member.

4. The combination as set forth in claim 3, wherein spring adapters are provided at opposite ends of said coiled compression spring, the upper adapter being detachably secured to the upper end of the tubular body, and the lower adapter being adapted to engage said sealing member.

5. The combination defined in claim 1, wherein the axial openings through said tubular mandrel and sealing member are substantially as large as the smallest inside diameter of said drill string.

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