Jan. 14, 1958 J. S. BECK 2,819,879

SUSPENSION DRILLING DEVICE AND JAR

Filed Jan. 9, 1957

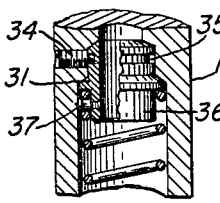

FIG. 8.

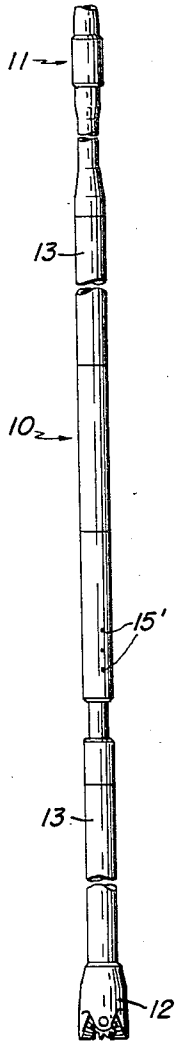

FIG. 1.

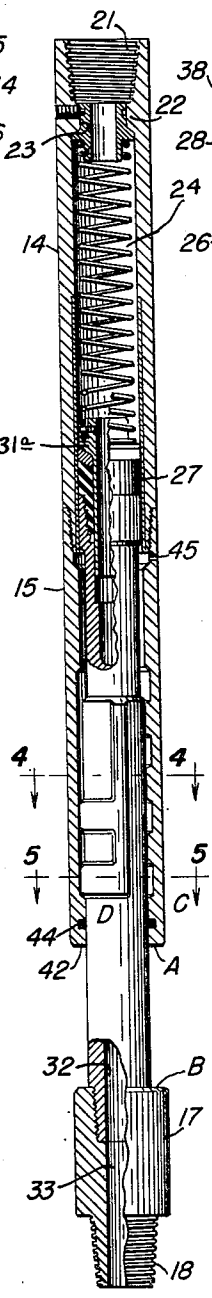

FIG. 2.

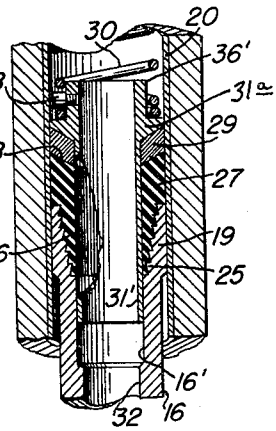

FIG. 7.

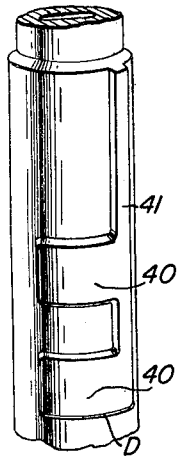

FIG. 3.

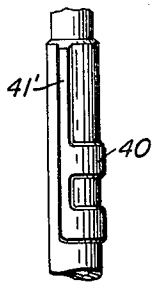

FIG. 9.

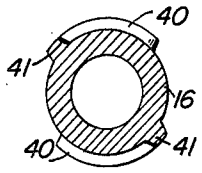

FIG. 4.

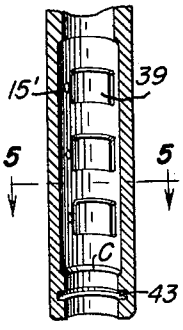

FIG. 6.

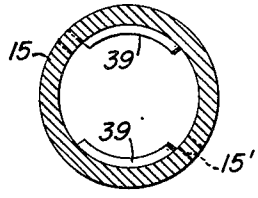

FIG. 5.

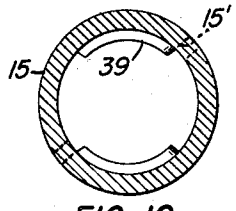

FIG. 10.

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SUSPENSION DRILLING DEVICE AND JAR

Julius S. Beck, Long Beach, Calif., assignor to J. E. Hill, Fort Worth, Tex.

Application January 9, 1957, Serial No. 633,357

3 Claims. (Cl. 255—28)

This invention relates to suspension drilling devices for connection in drill strings, and this application is a continuation in part of my copending application Serial No. 611,461, filed September 24, 1956.

Suspension drilling, as described in the referred to copending application, has the advantage of maintaining optimum weight on a drill bit when drilling a well. Generally, this is accomplished by a weighted telescoping tool having a resilient piston type seal therein and passage means through the tool for circulating drilling fluids. When the seal of the tool is subjected to high or varying pressures there is a tendency to distort and restrict the opening through the seal. Also, well temperatures and chemicals used in drilling adversely affect the resiliency of the seal so as to decrease its efficiency. For example, heat may either cause the seal to become too hard or too soft to operate efficiently. Similarly, some chemicals used in drilling and lost circulation materials soften the seal, and when the latter is compressed the opening through the seal is restricted and thereby retards circulation.

The suspension drilling device, described in my copending application, also serves as an effective up and down jar. The present invention, which is directed to an improved seal support, is applicable to jars of this type even though the device is not used as a suspension drilling tool.

An object of the present invention is to enclose the above referred to seal and support the same against inward distortion and, at the same time, protect the seal from the harmful effects of heat in the bore hole and chemicals in circulating fluids.

Another object is to provide an improved support for a resilient piston type seal in a suspension drilling device or jar, and which support provides long uninterrupted circulation of drill fluids before replacing the seal.

A particular object is to provide and maintain full opening through the seal regardless of pressures applied thereto and regardless of the influence of chemical action on the resilient material, and whereby survey instruments, pressure bombs and other devices and materials, such as lost circulation materials and solids may pass therethrough.

A further object is to provide, in a suspension drilling tool or jar, a seal capable of preventing injected fluids, passing downwardly through the device, from directly entering the annular chamber between the lower tubular body and the upper outer surface of the mandrel of a construction such as illustrated and described in the referred to copending application.

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.

Figure 10 is a transverse sectional view similar to Figure 5 but showing an arrangement of relief holes in the tubular body for use in conjunction with the mandrel shown in Figure 9.

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 piston type 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 cupped retainer **29**. The retainer **29** is held in its described position by means of a coiled compression spring **30** having spring adapters **31**, **31***a* on each end thereof. The upper adapter **31** engages the inwardly formed shoulder **22** of the cylinder **14** whereas the lower adapter **31***a* 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 and other 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***a* is provided with a reduced diameter, as at **36'**, for receiving the upper 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.

An improvement in the present invention is the provision of a tubular extension or sleeve **31'** integral and concentric with the lower spring adapter **31***a*. The extension **31'** projects downwardly through the cupped retainer **29** and the seal **27** into a shouldered cylindrical enlargement **16'** in the upper end of the mandrel **16** where it is a sliding fit. The inside diameter of the extension **31'** is substantially equal to the inside diameter of the mandrel, both of which are large enough to pass conventional wire line suspended tools and devices therethrough.

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**.

Relief holes **15'** may be provided in the body **15** and at the sides of the bosses **39** for relieving fluid entrapped between the same, keys **40** and the vertical rib **41**. As shown in Figure 5, the holes **15'** are located for coaction with the arrangement of keys **40** and rib **41** illustrated in Figure 3, and as shown in Figure 10 the holes **15'** are located for the arrangement of keys **40** and rib **41'** illustrated in Figure 9.

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 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 **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 stem **11** becomes stuck, either while drilling, going into the hole, or coming out, then the device **10** may be used for determining whether the upper length or the lower length of the 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 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 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 device, the upper length of drill string is turned to the right several turns until con-

siderable 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 **40** 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** from 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 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 ports **45** in the side of the tubular body **15** admit and discharge 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, 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, and a sleeve snugly fitting within and extending axially through said sealing member and serving to retain the same against inward distortion.

2. The combination as set forth in claim 1, wherein the lower end of the sleeve slidably fits in the upper end of the tubular mandrel.

3. The combination as set forth in claim 1, wherein the means urging said sealing member into engagement with the wall of the tubular body comprises a coiled compression spring mounted in the tubular body and arranged to bear against the sealing member and the lower end of the spring is secured to an adapter, and the sleeve projects downwardly from the adapter.

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