April 27, 1965 J. C. MASON 3,180,433

HYDRAULIC JARRING TOOL

Filed Aug. 24, 1961

FIG. 2

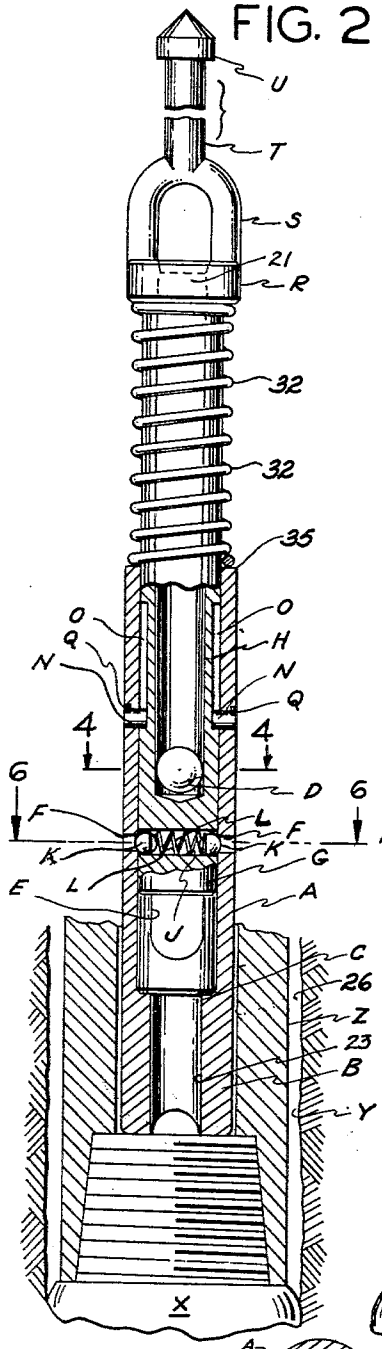

FIG. 3

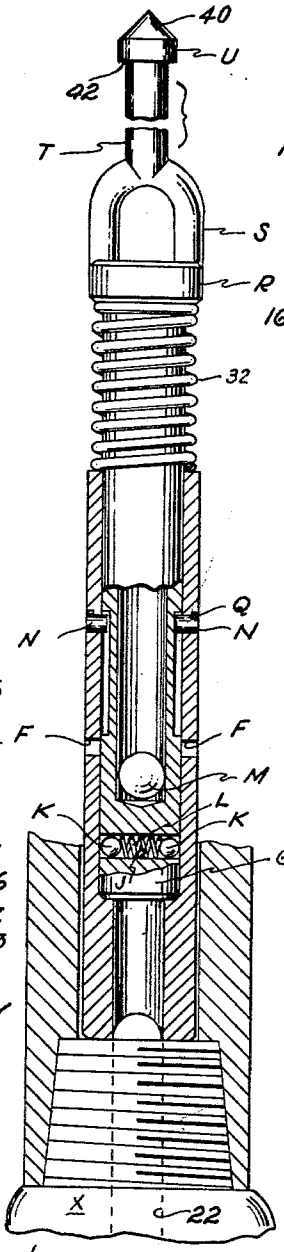

FIG. 1

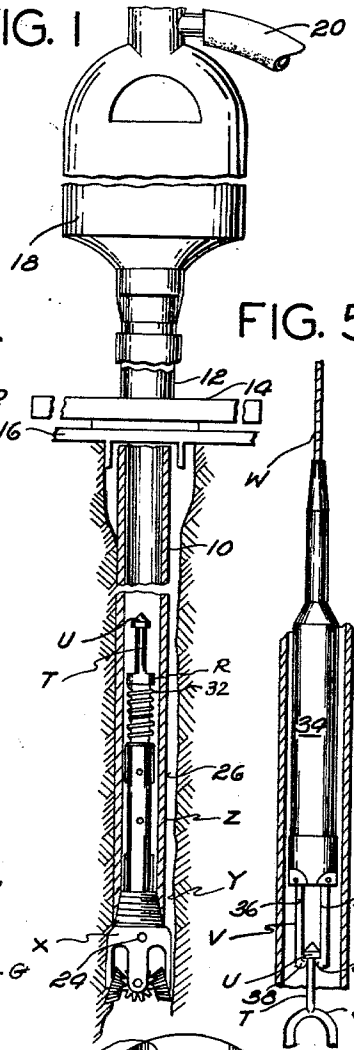

FIG. 5

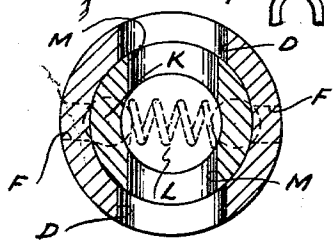

FIG. 4

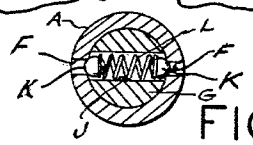

FIG. 6

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HYDRAULIC JARRING TOOL

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The present invention relates generally to oil field drilling equipment, and more particularly to a hydraulically operated jar that may be dropped through a string of drill pipe and a drill collar to come to rest in contact with a collar-supported bit to impact against the bit and free it, the drill collar, or drill pipe from a stuck position in a bore hole.

Although a number of hydraulically operated jars have been devised and used in the past, these devices have suffered from certain operational disadvantages in that they had to be lowered into the well by a string of tubing or other means which is a time-consuming and expensive operation, or included initially as a part of the operating string that rotates the bit.

A major object of the present invention is to provide a hydraulically operated jar that may be dropped downwardly through a drill string and drill collar to contact the bit or portion of the collar and impact against the same, which when the bit, drill collar or drill string freed, is easily recovered by use of a cable-supported retrieving tool.

Another object of the invention is to supply a hydraulically operated jar that has an extremely simple mechanical structure, is quick and easy to use, can be fabricated from standard, commercially available materials, requires a minimum of maintenance attention, and can be sold or leased at a sufficiently low figure as to encourage the widespread use thereof.

Yet another object of the invention is to furnish a hydraulically operated jar of such rugged structure that little or no damage can be done thereto even when the jar is subjected to the most harsh and careless treatment.

A still further object of the invention is to provide a means to free a stuck bit, drill collar, or portion of drill pipe without having to resort to determination of free points, stuck points, use of a magnet detector, or attempting a back-off operation, all of which means are not only time-consuming but exceedingly expensive.

Yet another object of the invention is to provide a hydraulically operated jar that is activated by the kinetic energy of a downwardly moving liquid column in the tubular member in which the invention is disposed.

A still further object of the invention is to provide a hydraulically actuated jar through which fluid under pressure can circulate until a predetermined velocity is attained, with the circulation being suddenly obstructed when this predetermined velocity is reached, with the kinetic energy of the moving column of liquid being utilized to impact a mandrel on an anvil forming a part of the invention when the circulation is terminated.

Yet another object of the invention is to supply a hydraulic jar that is adapted to be either removably positioned relative to a drill bit or included as a permanent part of the bit and drill pipe assembly.

These and other objects and advantages of the present invention will become apparent from the following description of a preferred form thereof, and from the accompanying drawings illustrating that form, in which:

FIGURE 1 is a side elevational view of the invention after it has been dropped through a string of drill pipe and a drill collar to rest on the upper end of a stuck bit;

FIGURE 2 is a combined side elevational and longitudinal cross-sectional view of the invention showing the mandrel thereof in a first raised position;

FIGURE 3 is a combined side elevational and longitudinal cross-sectional view of the invention showing the mandrel in a second position wherein it is in contact with the bit.

FIGURE 4 is a transverse cross-sectional view of the device taken on line 4—4 of FIGURE 2;

FIGURE 5 is a partial side elevational view of the upper portion of the invention shown being engaged to be moved upwardly through the drill string; and

FIGURE 6 is a transverse cross-sectional view of the invention taken on line 6—6 of FIGURE 2.

With continuing reference to the drawing for the general arrangement of the invention, it will be seen to include a tubular shell A, the lower wall portion of which is substantially heavier and defines an anvil B. Shell A and anvil B provide a ring-shaped surface C at the junction thereof. Shell A has at least one upper port D, as may best be seen in FIGURE 4, formed therein as well as one lower elongate port E. Two oppositely disposed transverse bores F are formed in shell A, which are preferably situated below port D and above the lower extremity of port E.

In FIGURES 2 and 3 it will be seen that a cylindrical mandrel G is slidably movable in the tubular shell A. Mandrel G includes as an integral part thereof an upper tubular sleeve H that extends upwardly therefrom beyond the upper end of shell A. A transverse bore J is formed in the lower portion of mandrel G which is slightly larger in transverse cross section than that of the two bores F. When the mandrel G is in a first position as shown in FIGURE 2, the bore J is coaxially aligned with two bores F.

The bore J has two balls K disposed in opposite end portions thereof, and these balls are at all times urged outwardly in opposing directions by a compressed helical spring L situated within the confiines of bore J. The balls K are of larger diameter than that of the bores F. When the mandrel G is in the first position shown in FIGURE 2, it is so removably held by outer portions of the balls K which extend into the inner portions of the two bores F.

Sleeve H has at least one port M formed therein that is in transverse alignment with the port D (FIGURE 4) when the mandrel G is in the first position shown in FIGURE 2. In FIGURE 4 the invention is shown as including two oppositely disposed first ports M which are transversely alignable with the two upper ports D. Sleeve H is prevented from longitudinally separating from shell A, as well as rotating relative thereto, by two transversely positioned, oppositely disposed pins N that extend inwardly from the side wall of the shell A. The inner portions of the pins N slidably engage two oppositely disposed, longitudinally extending slots O formed on the exterior surface of sleeve H. Pins N are preferably held in two transverse bores P formed in shell A by conventional locking means Q. The upper end of sleeve H has an outwardly extending ring-shaped collar R mounted thereon. A yoke S extends upwardly from collar R and supports an upright rigid member T, which latter member terminates in an enlarged engageable portion U that can be removably engaged by an engaging member V, as may best be seen in FIGURE 5. Engaging member V is supported on the lower end of a cable W.

In a rotary drilling operation, a bit X may become stuck in a bore hole Y, as may the drill collar Z that supports the bit on the lower end thereof. The drill collar Z is in turn supported on the lower end of a drill string 10 that extends upwardly to a drill stem or Kelly 12. The drill stem is rotated by a power-driven rotary table 14 and is vertically movable relative thereto. Table 14 is supported on a floor 16 of a derrick (not shown).

The upper end of the drill stem 12 is rotatably supported in a swivel 18. Liquid in the form of drilling

mud is supplied under pressure from a hose 20 to the swivel 18 by a pump (not shown), and thereafter flows downwardly therethrough to the drill stem 12. The fluid flows through drill stem 12 and downwardly through the drill string 10 and drill collar Z. At the lower end of drill collar Z, fluid flows therefrom into a passage 22 in the bit X that is in communication with one or more discharge ports 24 formed in the bit. After discharging from ports 24, fluid flows upwardly in an annulus-shaped space 26 defined between the bore hole Y and the exterior surfaces of the drill collar Z and drill string 10 to a reservoir (not shown) at the ground surface where the fluid is again picked up by the suction of a pump (not shown) and recirculated through the hose 20 to the swivel 18.

The jarring tool of the present invention will normally be used to free the drill bit X after the bit has progressed to a considerable depth in the bore hole Y. When bit X is so disposed, a column of liquid mud will fill the drill collar Z and drill string 10, as well as the annulus-shaped space 26. When it is necessary to use the invention to free the drill bit X, the tool is simply inserted within the drill stem 12, and allowed to drop downwardly therethrough into the drill string 10. The transverse cross section of the mandrel G and the sleeve H thereof is substantially less than the interior cross section of the drill collar Z, tubing string 10, and drill stem 12. The invention continues to move downwardly through drill string 10 by gravity until it comes to rest at the lower end of drill collar Z in contact with the upper end of bit X, as shown in FIGURE 2. Due to the viscosity of the liquid mud standing in the drill string 10 and drill collar Z, the downward movement of the invention by the force of gravity is slowed down to the extent that the invention is not damaged when it comes to rest in the position shown in FIGURE 1.

After the jarring tool has been so disposed, the pump (not shown) is speeded up to start discharge of liquid at a relatively high velocity through the hose 20 into the swivel 18 and thence downwardly through the drill string 10 to the invention. The downwardly moving liquid in drill pipe 10 enters the upper open end 21 of sleeve H and flows downwardly through the sleeve to discharge through the ports M and D into the space 26. As the velocity of the downwardly moving liquid increases, a back pressure develops as the liquid tends to escape at an increasing rate from the ports M and D. When this back pressure increases to a predetermined magnitude, the inwardly directed forces on the balls K is greater than the outwardly directed forces to which the balls are subjected by the compressed spring L. The balls K then move inwardly to permit mandrel G to move downwardly from the first position shown in FIGURE 2 to the second position shown in FIGURE 3. This movement of mandrel G takes place very rapidly after the initiation thereof, and as a result the mandrel impacts with very considerable force on the anvil B.

When the invention is in the first position, the liquid flowing downwardly through sleeve H flows outwardly therefrom into space 26 through ports M and D. Liquid in space 26 that has discharged through ports M and D reenters the invention through the port E to flow downwardly through a passage 23 in anvil B to the passage 22. Liquid discharges from passage 22 into annulus-shaped space 26 as previously mentioned, and is recirculated by the pump (not shown) through hose 20 to swivel 18.

When the mandrel G moves from the first position to the second position, the port E is completely obstructed, and the downwardly moving column of liquid in drill string 10 cannot flow through the invention to passage 22 and thence to space 26. This interruption of flow of the downwardly moving liquid column is sudden, and is terminated in the length of time it takes mandrel G to move from the first to the second position. The downwardly moving liquid column has a very substantial kinetic energy, and the major portion thereof is exerted in impacting the mandrel G on anvil B, with the jar of this impact being transferred to bit X or other desired portion of the drill string 10 to free the same from a stuck position.

A helical spring 32 encircles the upper portion of sleeve H, with the upper end of the spring abutting against the lower surface of collar R and the lower end of the spring resting on an upper end 35 of shell A. When mandrel G moves downwardly in shell A due to the back pressure mentioned hereinabove, the spring 32 is compressed to the position shown in FIGURE 3 and tends to return the mandrel and sleeve to the first position shown in FIGURE 2.

After the mandrel G has impacted against the ring-shaped surface C due to the back pressure build-up, the pump (not shown) is stopped, the spring 32 expands and returns the mandrel G from the second position (FIGURE 3) to the first position (FIGURE 2). As mandrel G returns to the first position, the balls K automatically move outwardly into the bores F due to the compression of spring L to again removably support the mandrel G in the first position. The operation described hereinabove is thereafter repeated until the impacting of mandrel G on the bit X is sufficient to loosen the bit X or drill collar Z from the stuck position it occupied in bore hole Y.

From the above description of the operation of the invention and the structure thereof, it will be seen that blows of substantial magnitude can be given directly to the drill bit X. The magnitude of the force imparted to the bit X is dependent on the height of the fluid column in the bore hole Y, the density of the fluid, and the velocity with which the fluid is circulated when the invention assumes the position shown in FIGURE 3.

The engaging member V, as may best be seen in FIGURE 5, includes an elongate heavy cylindrical body 34 that depends from cable W. Two or more laterally spaced arms 36 are pivotally supported in downwardly extending positions from the lower end of body 34. Inwardly extending claws 38 are formed on the lower ends of arms 36. When the body 34 is lowered into a position adjacent the invention, the arms 36 first pivot outwardly when they come into contact with an upper conical face 40 of engageable member U and then pivot inwardly by gravity after the claws 38 have passed below the member U and engage same. If the cable W and the body 34 are then moved upwardly, the upper edge surfaces of the claws 38 engage the lower surface 42 of the member U, and the invention can be retrieved from the bore hole Y. The invention is then brought to the ground surface, removed from the tubing string 10, and stored until again needed.

Although in the drawing the invention is shown as transferring the energy of impact directly to the upper surface of bit X, it will be apparent that the diameter of the anvil B can be such as to transfer such impact energy to a seat (not shown) formed in the drill collar Z, or other desired portion of the collar Z or drill string 10. Of course, it is desirable that the surface which receives the impact energy be as close as possible to the part of the drill string assembly that is stuck, which in the majority of cases will be the bit X. Also, if desired the invention need not be movable relative to drill string 10 but can be included as a part of the collar Z, or other desired portion of the drill string assembly.

Although the present invention is fully capable of achieving the objects and providing the advantages hereinbefore mentioned, it is to be understood that it is merely illustrative of the presently preferred embodiment thereof and I do not mean to be limited to the details of construction herein shown and described, other than as defined in the appended claims.

I claim:

1. A jarring tool capable of being dropped down through a drill string and a drill collar to a position in contact with a bit supported from the lower end of said

collar when said drill string and collar are in a bore hole filled with a fluid with said fluid standing as a column in said drill pipe and collar, including: a tubular shell having an upper port, a lower port, and two oppositely disposed transverse bores; a tubular anvil supported from the lower end of said shell, with said anvil resting on said bit so as to transmit impacts thereto; a mandrel slidably movable in said shell; a sleeve extending upwardly from said mandrel beyond the upper end of said shell, said sleeve having a first port therein that is transversely aligned with said upper port when said sleeve and mandrel are in a first elevated position above said anvil; pressure-sensitive holding means carried by said mandrel and in alignment with said transverse bores in said shell so as to be subjected to the pressure of said fluid in an annulus between said tool and drill collar, with said holding means maintaining said mandrel and sleeve in said first position until said holding means is subjected to greater than a predetermined downward force that is generated by pumping said fluid into said drill pipe and drill collar downwardly through said shell, outwardly through said upper port to develop a back pressure in said shell greater than said predetermined downward force, with said fluid as discharged from said upper port entering said annulus which fluid flows from said annulus through said lower port into said shell to enter a passage formed in said bit that extends therethrough to communicate with said fluid in a second annulus-shaped space defined between said bore hole and the exterior surfaces of said drill collar and said drill pipe; means for maintaining said mandrel and sleeve in a non-rotating position in said tubular shell; and spring means for returning said mandrel and sleeve to said first position after said back pressure has forced said mandrel and sleeve downwardly from said first position to a second position where said mandrel impacts said anvil and imparts a jar to said bit.

2. A jarring tool as defined in claim 1 wherein said pressure-sensitive holding means are two laterally separated

balls movably disposed in a second transverse bore that extends through said mandrel, a compressed helical spring disposed in said second bore that at all times tends to move said balls outwardly away from one another to seat in said bores in said shell that are smaller in transverse cross section than that of said second bore, said bores in said shell and said second bore being in coaxial alignment when said mandrel and sleeve are in said first position, and outer portions of said balls extend into said first bores to hold said mandrel and sleeve at said first position.

3. A jarring tool as defined in claim 1 wherein said means for maintaining said mandrel and sleeve in said non-rotating position is at least one pin that extends inwardly from said shell, and said pin slidably engages a slot formed in said sleeve.

4. A jarring tool as defined in claim 1 wherein said shell has an outwardly projecting collar mounted on the upper end thereof and said spring means is a helical spring that encircles the portion of said sleeve disposed above said shell, said spring having the lower end thereof in abutting contact with the upper end of said shell, and the upper end of said shell bearing against said collar.

5. A jarring tool as defined in claim 1 which also includes engageable means mounted on the upper end portion thereof for retrieving said tool from a bore hole by use of cable-supported engaging means.

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