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[54] ROTARY JAR

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[52] **U.S. Cl.** **175/297,** 166/178

[51] **Int. Cl.** **E21b 1/10**

[58] **Field of Search** 175/296, 297; 166/178

[56] **References Cited**

UNITED STATES PATENTS

3,005,505	10/1961	Webb	175/297
3,088,533	5/1963	Sutliff	175/297
3,388,755	6/1968	Webb	175/297
3,405,773	10/1968	Sutliff et al.	175/297
3,429,389	2/1969	Barrington	175/297
3,562,807	2/1971	Slator et al.	175/297
3,570,612	3/1971	Slator	175/297

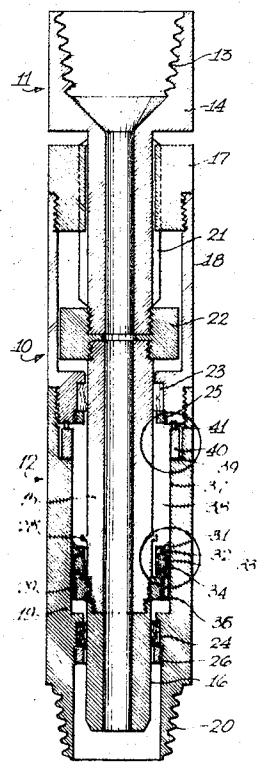
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[57] **ABSTRACT**

A rotary jar is disclosed for use in well bores when a tool, attached to the jar, becomes so stuck that normal tension on the drill string will not release it. The rotary jar has an outer housing and an inner mandrel with appropriate seals therebetween defining an annular working chamber. A knocker is attached to the mandrel and an anvil is attached to the housing. The working fluid in the working chamber exhibits low viscosity changes with high temperature changes. Within the chamber are located a piston and a valve combination so arranged that when the drill string is under high tension, fluid is forced in minute quantities through the valve combination. This is actually a mutual extension of the mandrel and housing which continues until the piston and valve combination come into contact with an annular sleeve in the chamber. The sleeve moves with the piston and valve combination allowing fluid to dump therebehind, thereby allowing the knocker and anvil to come into jarring contact. Provision is made for resetting the jar so that it may be operated continuously over over long periods of time.

10 Claims, 3 Drawing Figures



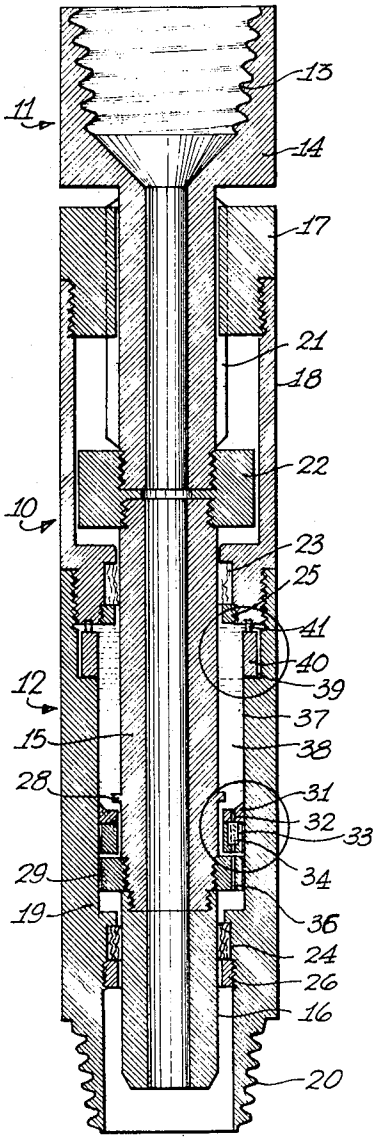


Fig. 1.

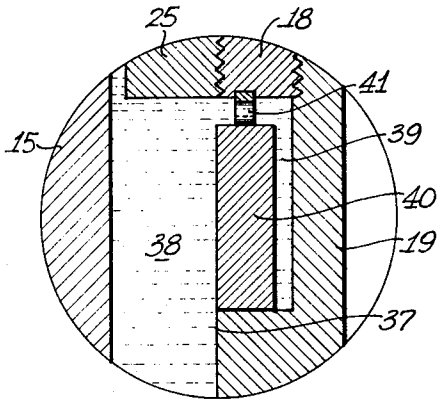


Fig. 2.

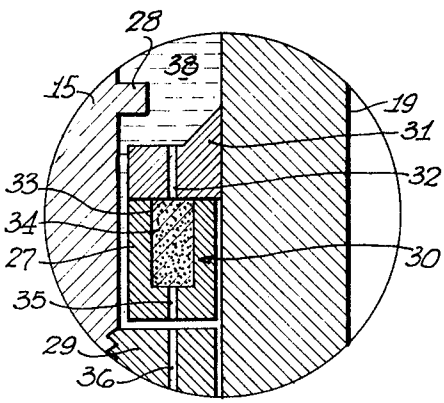


Fig. 3.

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ROTARY JAR

The present invention relates in general to drilling equipment and more particularly to rotary jars for releasing tools trapped in well bores.

Well jars are extensively known in the prior art and they are of two general types, mechanical and hydraulic. Each type has its own particular disadvantages, the mechanical suffering from accelerated wear and the hydraulic suffering from viscosity changes with temperature. During a jarring operation, the jar may be activated as often as two or three times a minute, for periods of up to many days, and the internal parts of the jar could be subject to very high pressures, at times as much as 50,000 or 60,000 P.S.I. When a well-tool is so stuck in the bore that tension alone will not release it, it becomes extremely vital that a jar, if used, be in perfect working order. A jar that has failed is of no use, and it becomes probable that the stuck tool will be lost if the drill string breaks under tension.

The rotary jar of the present invention overcomes the problems of the prior art devices by providing a rotary jar having an inner mandrel, an outer housing, a knocker and anvil in conventional relationship, piston and valve means wherein the valve contains no moving parts and is temperature variable and a working fluid of Silicone 200 which exhibits very small viscosity changes over a wide temperature range. The valve means permits minute quantities of the working fluid to pass from a working chamber above the piston to a chamber below the piston, during operation of the rotary jar. When the piston and valve means are adjacent a movable sleeve in a recess within the housing, the sleeve will lift from its seat in the recess to permit the fluid remaining in the working chamber to dump behind the piston. This releases the resistence of the working fluid, allowing the knocker and anvil to come into jarring contact.

The invention will now be described in greater detail with reference to the drawings wherein:

FIG. 1 illustrates a vertical section of the rotary jar of this invention, showing the internal structure.

FIG. 2 is an enlargement of a portion of FIG. 1 and illustrates the recess and sleeve combination in the rotary jar of this invention.

FIG. 3 is an enlargement of another portion of FIG. 1 and illustrates the valve combination of the invention.

The rotary jar of this invention is shown in cross-section in FIG. 1. Reference numeral **10** designates the rotary jar which, in turn, is constructed from two mutually extensible basic subassemblies, an inner mandrel **11** and an outer housing **12**. It is the interaction between various components of these subassemblies which permits the rotary jar to function as intended.

The inner mandrel **11** is assembled from three cylindrical, hollow sections, namely the integral head and main mandrel **14**, the upper piston mandrel **15** and the lower piston mandrel **16**. In a preferred embodiment of the invention the integral head and main mandrel **14** includes a box connection **13**. Box connection **13** is provided with an internal thread which may be connected to an external thread on the pin end of a drill string. Thus, when placed in a drill hole, the box connection **13** would be the uppermost component of the rotary jar **10**.

The lower portion of integral head and main mandrel **14** has an outside diameter less than that of box connection **13**. This portion is provided with a plurality of longitudinally directed splines **21**, spaced around the circumference, the use of which will be discussed later. The lowest end of the main mandrel **14** is provided with an external thread for reception of knocker **22**. The knocker will be described in detail later as well; it is sufficient to say at this point that it provides the means for connecting main mandrel **14** to the upper piston mandrel **15** which, in turn, is threadedly connected to lower piston mandrel **16**.

The outer housing **12** is also constructed from three sections, namely spline housing and impact sub **17**, knocker housing **18** and hydraulic cylinder **19**. Each of these sections is substantially annular in cross-section, the inner diameters thereof being greater than the outer diameters of the three inner mandrel sections respectively. The three outer housing sections are threadedly connected together, the hydraulic cylinder **19** being the lowermost component of the rotary jar **10** when it is in use in a drill hole. The lowest portion of hydraulic cylinder **19** is provided with an external thread to which a drilling tool may be attached.

As mentioned previously, the lower portion of main mandrel **14** is provided with a plurality of longitudinal splines **21** projecting radially therefrom towards the outer housing. Spline housing and impact subs **17** has an inner diameter which is slightly greater than the outside shaft diameter of the lower portion of main mandrel **14**. The spline housing **17** is provided with a plurality of grooves in its inner wall to correspond to the splines **21**. The interaction between the splines **21** and the grooves prevents any torque from being imparted to the internal parts during operation of the rotary jar and also helps prevent any binding between the outer housing and the main mandrel during mutual extension or contraction.

The length of the spline housing and impact sub **17** is less than that of the lower portion of the main mandrel **14**. Thus, longitudinal movement of the spline housing and impact sub **17** is permitted between the lower surface of the box connection **13** and the upper surface of knocker **22**. It is the jar-ring contact between the bottom surface of impact sub **17**, which shall henceforth be known as the anvil, and the top surface of knocker **22** which is the desired effect during operation of the rotary jar of the invention.

The knocker itself, as mentioned above is threadedly connected to the main mandrel **14**. It is shaped as an annular collar with an outside diameter essentially the same as the surface diameter of the anvil. In addition to the internal thread for connection to the main mandrel, a second internal thread is provided for connection to a corresponding external thread on the upper piston mandrel **15**. Since both the anvil and the knocker are subject to high impact loading, it is preferable to use hardened steel for their construction.

Knocker housing **18** provides an inner chamber of a diameter slightly greater than the outside diameter of knocker **22**, the relative movement of knocker **22** with respect to housing **18** being confined within this chamber. Housing **18** has a portion below the knocker which extends radially inwardly into close proximity with the upper piston mandrel **15**. Annular upper

packing gland 23 is located in an annular recess in this portion, the gland providing a fluid-tight seal between the upper piston mandrel 15 and the housing 18. The gland is held in place by upper gland nut 25 which is threadedly engaged with the inwardly extending portion of housing 18.

Connected to knocker housing 18 by cooperating external and internal threads is annular hydraulic cylinder housing 19, defining an annular working chamber 37 between its inner surface and the upper and lower piston mandrels 15 and 16. The lower end of the housing 19 is provided with a radially inwardly extending portion incorporating lower packing gland 24 and lower gland nut 26 in a manner similar to that already described for housing 18. The location of the lower packing gland 24 is such that even during full relative extension of inner mandrel 11 and outer housing 12, the gland 24 will provide sealing contact with lower piston mandrel 16. The longitudinal limits of the working chamber 37 are therefore the upper and lower packing glands 23 and 24.

Piston and valve means are attached to the upper piston mandrel 15 and are located within the working chamber 37. Annular piston 27 is slidably received on mandrel 15 and its outer diameter is sufficiently less than the inside diameter of cylinder housing 19 to permit fluid to pass between the outer and inner wall surfaces respectively. The inner diameter of piston 27 is substantially greater than the outside diameter of piston mandrel 15 so as to permit the passage of fluid therebetween as well. Piston 27 is slidable longitudinally along mandrel 15 between upper and lower limits provided respectively by a ring 28 which extends radially outwards from mandrel 15 into working chamber 37, and an annular piston seat 29 which is threadedly attached to mandrel 15 and which is slightly less in outer diameter than the piston 27 itself. When the outer housing 12 and the inner mandrel 11 are in a fully contracted or a fully extended relation, the piston and valve means will be adjacent the lower and upper packing glands 24 and 23 respectively.

The valve means are generally designated by reference numeral 30. Annular seal 31, in the form of a cup, is located between the upper surface of piston 27 and the lower surface of ring 28. As with piston 27, the inner diameter of seal or cup 31 is substantially greater than the outer diameter of piston mandrel 15, but less than the outer diameter of ring 28. The outer diameter of cup 31 is actually slightly greater than the inner diameter of cylinder housing 18 so that the cup which is constructed from a suitably resilient material exerts an outward force onto the inner surface of cylinder housing 18. Since the friction between the surfaces in contact must be kept at a minimum, a material such as is sold under the trademark "Teflon (R)" is recommended for cup 31.

A single, longitudinal, small-diameter bore 32 is provided in cup 31 to permit quantities of a working fluid to pass therethrough during mutual extension of mandrel 11 and housing 12. The bore 32 leads to counterbore 33 in piston 27, the bores 32 and 33 being on the same centerline. Counterbore 33 is of a larger diameter than bore 32 and extends only part way through piston 27. The counterbore may receive valve cartridge 34 which is the main factor in restricting the flow of fluid through valve means 30. The valve cartridge is a porous material and is preferably temperature variable so that a high temperature, which would reduce the viscosity of a fluid, would expand the cartridge to thereby reduce the porosity and restrict fluid flow. Materials such as porous brass or bronze are recommended for the valve cartridge 34. Bores 35 and 36 are provided in piston 27 and piston seat 29 respectively to take fluid from the valve cartridge 34 to below valve seat 29 (i.e. below cup 31). These bores are preferably of the same diameter as, and axially aligned with, bore 32.

An annular recess 39 is provided in the inner wall of cylinder housing 19. Within the recess is located annular sleeve 40, the inner diameter of which is substantially equal to the inner diameter of housing 19. The sleeve 40 is smaller than the recess 39 so that fluid may surround the sleeve. When in its rest position, the sleeve 40 is positively forced longitudinally against its seat in recess 39 by wave spring 41 which is located in an annular groove provided in the bottom surface of knocker housing 18.

Lastly, the working chamber 37 is filled with working fluid 38 when housing 12 and mandrel 11 are in their mutually contracted condition. It is desirable to use a fluid which exhibits small changes in viscosity over a large temperature range. A fluid such as is sold under the trademark "Silicone 200" would be very suitable for this application. The fluid is introduced into the working chamber 37 through a filling hole, not shown, in cylinder housing 19.

The use and operation of the rotary jar of the invention will now be described in considerable detail. A tool is attached to the lower end of cylinder housing 19 via threads 20 and the box connection 13 is attached to a drill string. The working fluid 38 is introduced into working chamber 37 with the rotary jar in its fully contracted condition. The tool, rotary jar and drill string are introduced into the drill hole and operations continue normally. If the tool becomes tightly wedged in the hole, a jarring action may be applied through the rotary jar to attempt to dislodge the tool. This action will now be described.

A vertical strain is applied to inner mandrel 11 through the drill string. This causes cup 31 and piston 27 to rest solidly on piston seat 29, and puts working fluid 38 into compression. Since the only way to relieve the internal pressure in the working fluid is through valve 30, a small portion of fluid will pass through bore 32, porous cartridge 34 and bores 35 and 36 into that portion of working chamber 37 which is between piston seat 29 and lower packing gland 24. At an extremely slow speed, the piston 27 valve means 30 will rise, relatively, in working chamber 37. When cup 31 comes adjacent release sleeve 40 the combination of wall friction therebetween and fluid pressure behind and around release sleeve 40 causes the sleeve to move in the same direction as the piston 27. The working fluid 38 still remaining in compression in chamber 37 will be dumped around the sleeve and behind the cup 31, thereby drastically reducing the resistance of fluid 38 and permitting the upwards strain to bring knocker 22 into a jarring impact with anvil 17. The jarring effect is transmitted through outer housing 12 to the tool which might then be dislodged from its trapped position.

In order to reset the rotary jar of this invention so that it may be used again, it is only necessary to allow the weight of the drill string above to be set down on the jar. When this occurs, the piston **27** is lifted off valve seat **29** by the fluid **38** captured below it. This movement of piston **27**, and a corresponding movement of cup **31**, opens the seal which was in operation during mutual extension and which forced the working fluid through porous cartridge **34**. Fluid may now travel, rapidly, between the piston seat **29** and piston **27**, between piston **27** and piston mandrel **15** and between cup **31** and piston mandrel **15** into the portion of working chamber **37** located above cup **31**. It is, of course, necessary to provide longitudinal grooves or holes in ring **28** to permit passage of fluid, since the cup **31** will be in sealing contact with the lower surface of ring **28** during mutual contraction of the mandrel **11** and housing **12**. Once the mutual contraction is fully complete, the rotary jar is ready to deliver another blow when required.

It is readily apparent that the valve means **30** of the rotary jar of this invention contains no moving parts. Thus, the probability of failure due to wear is considerably reduced over jars found in the prior art. The only moving parts to be found in the rotary jar of this invention are in contact with seals or packing glands and consequently the probability of failure of these parts is also very small.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A rotary jar for an oil well tool which comprises a tubular housing having one end attachable to a well tool, a mandrel extending into said housing and having an end portion externally of said housing attachable to a drill string, said mandrel having a splined connection with said housing permitting non-rotative reciprocating movement of said mandrel relative to said housing, said housing having an internal annular shoulder constituting an anvil, said mandrel having an annular shoulder confronting said internal annular shoulder and constituting a knocker, means forming a substantially confined annular chamber between said mandrel and housing for reception of a working fluid, a piston in said chamber slidingly mounted on said mandrel, said mandrel having stop means limiting sliding movement of said piston on said mandrel and operable to apply reciprocating movement to said piston with said mandrel, said piston having a restricted fluid passage extending therethrough, control valve means in said passage and sleeve means in said housing and engagable by said piston to provide a fluid passage around said piston.

2. A rotary jar according to claim **1** wherein said control valve is a porous metallic cartridge.

3. A rotary jar according to claim **1** wherein said piston includes an annular ring slidably mounted on said mandrel and within said chamber, and wherein said stop means includes an annular rim on said mandrel located between said ring and said sealing means adjacent said knocker and an annular piston seat on said mandrel and within said chamber.

4. A rotary jar according to claim **3** wherein said control valve means includes an annular resilient piston cup within said chamber, having an inner diameter greater than the outside diameter of said mandrel but less than that of said rim and located between said piston and said rim, a small diameter bore through said cup in a direction longitudinal of said mandrel and between said mandrel and housing, a counterbore in said piston and having a diameter greater than the diameter of said bore to receive said porous cartridge, a second small diameter bore in said piston axially aligned with said bore and communicating said counter bore with said chamber, and a third small diameter bore through said piston seat and axially aligned with said second bore.

5. A rotary jar according to claim **1** wherein said knocker is a collar extending radially outwards from said mandrel into proximity with said housing and said anvil is a collar extending radially inwards from said housing into proximity with said mandrel.

6. A rotary jar according to claim **4** wherein said splined connection comprises radially extending longitudinal splines on said mandrel and extending from said knocker away from said chamber, and longitudinal grooves in said collar for cooperation with said splines to prevent turning of said housing relative to said mandrel.

7. A rotary jar according to claim **5** wherein said cartridge is porous brass or bronze.

8. A rotary jar for an oil well tool including an inner mandrel adapted for attachment to a drill string, an outer housing mutually extensible with said mandrel and adapted for attachment to a well tool, spline means between said mandrel and housing permitting non-rotative mutual extension of said mandrel and housing, annular knocker means on said mandrel, annular anvil means in said housing for coaction with said knocker, annular seal means in said housing, said seals being in sealing contact with said mandrel, being spaced apart longitudinally in said housing in one direction from said knocker and anvil, and defining a chamber therebetween in an annular cavity between said mandrel and housing, said chamber adapted to receive a working fluid which exhibits only small viscosity changes with large temperature changes, piston means slidable on said mandrel and located in said chamber, means forming a valve combination within said chamber whereby said valve combination includes a porous cartridge adapted to permit minute quantities of a working fluid therethrough during mutual extension of said mandrel and housing and means forming a bypass to said porous cartridge adapted to permit large quantities of a working fluid to pass therethrough during mutual contraction of said mandrel and housing, and means forming a recess in said housing within said chamber adjacent the seal nearest said knocker and anvil for receiving annular sleeve means such that when said valve combination and piston are moved adjacent said sleeve during mutual extension of said mandrel and housing, the sleeve will move with said valve combination and piston to permit rapid flow of a working fluid around said valve combination and piston effectively bypassing said porous cartridge to permit said knocker and anvil to come into jarring contact.

9. A rotary jar according to claim **3** wherein said sealing means are contained in radially inwardly extending portions of said housing at each end of the chamber so defined and are comprised of packing

glands held in place by gland nuts, each gland nut being annular in shape and having an external thread for coaction with an internal thread in said housing adjacent said packing gland.

10. A rotary jar according to claim 3 wherein said sleeve is biased away from the sealing means adjacent said knocker by resilient spring means and wherein said recess is sufficiently larger than said sleeve to permit fluid to surround said sleeve.

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