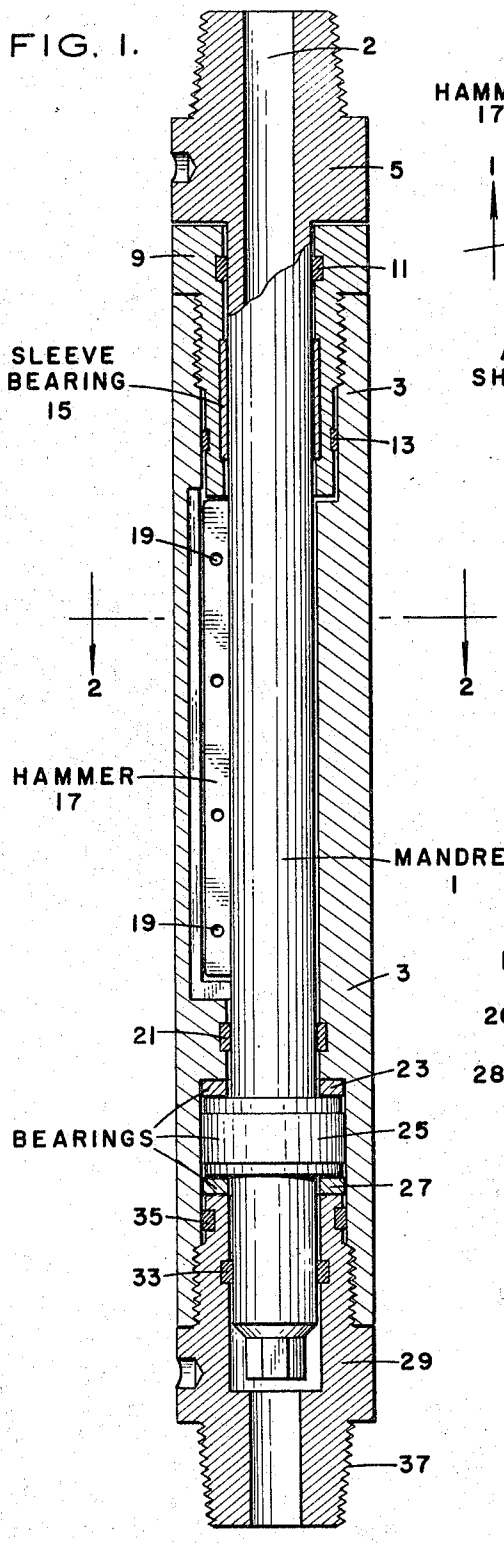
May 2, 1967 W. P. ORR 3,316,986

ROTARY JAR-TYPE WELL TOOL

Filed March 22, 1965

FIG. 1.



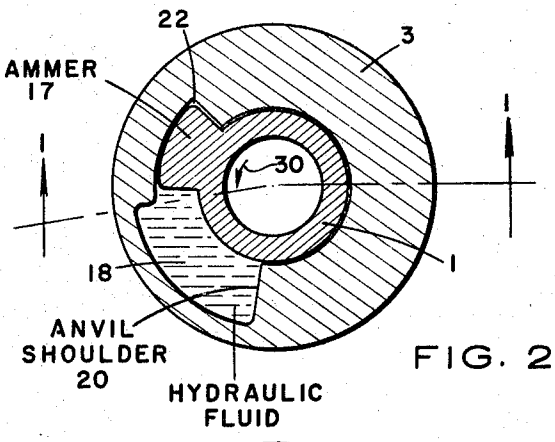


FIG. 2.

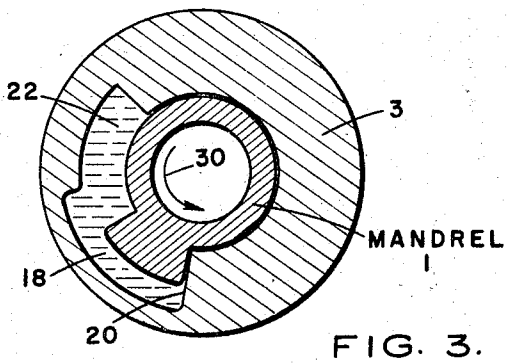


FIG. 3.

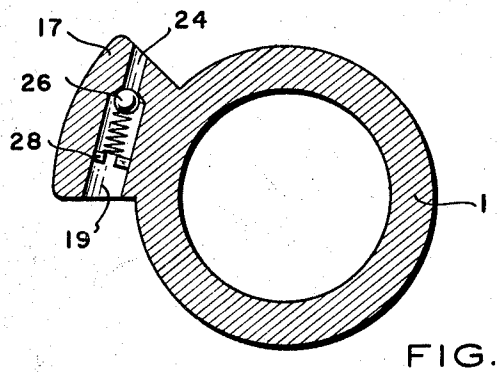


FIG. 4.

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ROTARY JAR-TYPE WELL TOOL

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4 Claims. (Cl. 175—297)

This invention relates to well tools for imparting a rotary jar or impact to a pipe string or tool that has become jammed in a well bore so as to free the pipe string or tool so that it can be recovered.

Pipe strings become jammed in wells for a number of reasons, such as differential pressure sticking, cave-ins, and pipe failures through deterioration thereof. Sometimes the torque on the pipe string can be increased to the point where the pipe string or tool can be freed, or a jar can be applied at the earth's surface to the same end. Generally speaking, however, it has been found to be more efficacious to connect a rotary jarring device to the stuck pipe string as near thereto as possible in the hole so that the force resulting from the jar or impact will not be absorbed in the relatively long pipe string extending to the earth's surface. Rotary jarring devices known to the prior art for the most part make use of vertical reciprocation of the upper pipe string to effect the jar. The impact force produced by such devices is necessarily limited. One object of the present invention is to produce a rotary jar device capable of producing an extremely high impact force.

Objects and features of the invention not apparent from the above discussion will become evident upon consideration of the following description of the invention when taken in connection with the accompanying drawings, wherein:

FIG. 1 is a side view, partially in cross section, illustrating a preferred embodiment of the invention;

FIG. 2 is a sectional view taken along section 2—2 of FIG. 1, illustrating the component parts of the apparatus of FIG. 1 in one operative position thereof;

FIG. 3 is a sectional view similar to FIG. 2 illustrating the component parts of the apparatus of FIG. 1 in another operative position thereof; and

FIG. 4 is an enlarged sectional view of a portion of the apparatus.

Briefly described, the present invention comprises a mandrel adapted to be coupled to an upper pipe string section and a sleeve section extending around the lower portion of the mandrel and adapted to be connected to a lower pipe string section. Segmental hammer spline means is provided on the mandrel and radially extends therefrom. An internal cavity or keyway in the sleeve section accommodates the hammer spline means and is considerably larger than the hammer spline means. The cavity is comprised of two portions of different diameters, the first portion having a diameter which is in snug fit with the hammer spline means for permitting only restricted liquid passage therebetween, and another portion of a diameter much greater than the diameter of the spline means and mandrel for permitting substantially unimpeded fluid movement therebetween. The cavity forms an anvil shoulder for reception of blows from the hammer. Means are provided for holding the hammer away from the anvil until large torque can be exerted on the mandrel so that the hammer will strike the anvil shoulder with great force, which will be transmitted to the lower pipe string section.

With reference now to FIG. 1, there is shown an elongated mandrel **1** including an upper coupling member **5** having tapered threads thereon for connection to an upper pipe string section which extends to the earth's surface through a borehole. Suitable apparatus for exerting rotary torque on the drill string, such as rotary drilling

apparatus, is connected to the upper end of the drill string. A bore **2** may extend through the mandrel for circulation of drilling fluid if such be desired. An annular bearing member **25** is connected to or is integral with the mandrel near the lower end thereof.

An elongated sleeve member comprising a plurality of sections **3**, **9**, and **29** is provided with an elongated bore therethrough, at least a portion of which is greater than the outside diameter of the greater portion of the mandrel **1**, so that the sleeve section extends around the lower portion of the mandrel. The lower mandrel section **29** is provided with a screw-threaded projection **37** similar to connecting section **5** for connecting the sleeve sections to a tool or lower pipe string section which is assumed to have been stuck in the well. Manifestly, other constructions for connecting two lower pipe string sections may be used. The lower sleeve section **29** is screw-threadedly connected to the middle sleeve section **3**. Bearing members **27** and **23** are respectively positioned below and above the mandrel bearing **25** so as to support the weight of the mandrel and the pipe string sections thereabove so that the mandrel can rotate within the sleeve sections. The upper sleeve section **9** is provided with a sleeve bearing **15** to permit the mandrel to rotate within the sleeve sections without binding.

A spline means or hammer **17** is affixed to or integral with mandrel **1** between sleeve bearing **15** and bearing **23**. The hammer **17** may be described as segmental and is of a sufficient size to strike a hard blow against anvil shoulder **20** without being broken off of mandrel **1**. The hammer rotates within a cavity formed within the sleeve section **3**, which cavity has a section **22** which is of a radius substantially that of the curved outer surface of hammer **17**. Thus, as the hammer rotates within the cavity section **22**, only a restricted amount of fluid will pass between the wall of the cavity section **22** and the curved outer surface of the hammer **17**. The cavity has a section **18** which is of substantially greater radius than the radius of section **22** so that the hammer can rotate freely therethrough and fluid can flow freely therearound. A passageway comprising sections **19** and **24** extends through the hammer section **17**, as shown in FIG. 2. The passageway section **19** is of substantially greater diameter than the diameter of section **24**, and the two sections are of substantially circular cross section with a tapered portion interconnecting them so as to form a seat for a ball **26** which is held within the passageway section **19** by one or more small projections **28** that permit liquid to flow around the ball and out of the passageway. Thus, when the mandrel is rotated counterclockwise, as shown by the arrow **30**, the ball **26** will seat so as to prevent passage of fluid through the passageway. The ball **26** may be held against the seat by means of a light compression spring, as shown in FIG. 4, or the passageway may be drilled on an incline extending downwardly from the larger opening **19**. However, when the mandrel is rotated clockwise, the ball will be unseated so that fluid can flow therearound and the mandrel can be freely turned.

The liquid within the cavity sections **22** and **18** may be water, oil, hydraulic fluid, or other suitable liquid. The liquid is held within the cavity by seals **21**, **11**, and **13**, the seals **11** and **21** being between the sleeve and the mandrel, and the seal **13** being between sleeve sections **3** and **9**. Seals **35** and **33** are provided to prevent well fluid from damaging the bearings **23**, **25**, and **27**.

Let it be assumed that the sleeve section **29** has been connected to a stuck pipe string or tool in the lower end of a well bore. When a large torque is exerted on the upper pipe string section connected to the mandrel **1** by suitable equipment at the earth's surface, the mandrel will turn very slowly within the sleeve member as fluid flows between the curved outer surface of hammer **17** and the

sleeve section wall defined by cavity section 22. As soon as the hammer passes out of the cavity section 22, the hammer will turn rapidly and strike anvil shoulder 20 with great force. This operation can be repeated as many times as is necessary until the stuck pipe string section or tool has been jarred loose.

Manifestly, by obvious and appropriate design changes, the invention can be used to jar by exerting torque in a clockwise direction.

The invention is not necessarily to be restricted to the specific structural details or arrangement of parts herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for connection to a drill string for imparting a rotary jar to a drill string section in the lower end of a borehole, comprising:

an elongated mandrel;

means for coupling said mandrel to an upper pipe string section;

a sleeve section extending around the lower portion of said mandrel;

means for connecting said sleeve section to a lower pipe string section;

hammer spline means on said mandrel radially extending therefrom;

an internal cavity in said sleeve section for accommodating said hammer spline means;

said cavity having a portion of a first diameter in snug fit with said hammer spline means for permitting restricted liquid passage therebetween, said cavity having a portion of a second diameter greater than said first diameter for permitting substantially unimpeded fluid movement therebetween, and forming an anvil shoulder for reception of blows from said hammer spline means;

sealing means between said mandrel and sleeve sections for preventing escape of fluid in said cavity; and

passageway means including check valve means in said hammer spline means for permitting free fluid flow therebetween only when said hammer spline means is turned away from said anvil shoulder.

2. Apparatus for connection to a drill string for imparting a rotary jar to a drill string section in the lower end of a borehole, comprising:

an elongated mandrel;

means for coupling said mandrel to an upper pipe string section;

a sleeve section extending around the lower portion of said mandrel;

means for connecting said sleeve section to a lower pipe string section;

hammer spline means on said mandrel radially extending therefrom;

an internal cavity in said sleeve section for accommodating said hammer spline means, said cavity forming an anvil shoulder for reception of blows from said hammer spline means; and

means for holding said hammer spline means away from said anvil until large torque is exerted on said mandrel.

3. Apparatus for connection to a drill string for imparting a rotary jar to a drill string section in the lower end of a borehole, comprising:

an elongated mandrel;

means for coupling said mandrel to an upper pipe string section;

a sleeve section extending around the lower portion of said mandrel;

means for connecting said sleeve section to a lower pipe string section;

hammer spline means on said mandrel radially extending therefrom;

an internal cavity in said sleeve section for accommodating said hammer spline means, said cavity forming an anvil shoulder for reception of blows from said hammer spline means; and

means for permitting substantially unimpeded movement of said hammer spline means in said cavity away from said shoulder, said cavity having substantially the same internal diameter as the external diameter of said hammer spline means and mandrel to restrict fluid passage therebetween over an arc of predetermined magnitude to permit torque buildup on said mandrel.

4. Apparatus for connection to a drill string for imparting a rotary jar to a drill string section in the lower end of a borehole, comprising:

an elongated mandrel;

means for coupling said mandrel to an upper pipe string section;

a sleeve section extending around the lower portion of said mandrel;

means for connecting said sleeve section to a lower pipe string section;

hammer spline means on said mandrel radially extending therefrom;

an internal cavity in said sleeve section for accommodating said hammer spline means;

said cavity having a portion of a first diameter in snug fit with said hammer spline means for permitting restricted liquid passage therebetween, said cavity having a portion of a second diameter greater than said first diameter for permitting substantially unimpeded fluid movement therebetween, and forming an anvil shoulder for reception of blows from said hammer spline means;

sealing means between said mandrel and sleeve sections for preventing escape of fluid in said cavity;

passageway means including check valve means in said hammer spline means for permitting free fluid flow therebetween only when said hammer spline means is turned away from said anvil shoulder;

an annular bearing affixed to said mandrel below said hammer spline means; and

a sleeve bearing in said sleeve section above said hammer spline means for engaging said mandrel.

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