April 1, 1952 C. C. BROWN ET AL 2,591,130

JAR

Filed March 24, 1947

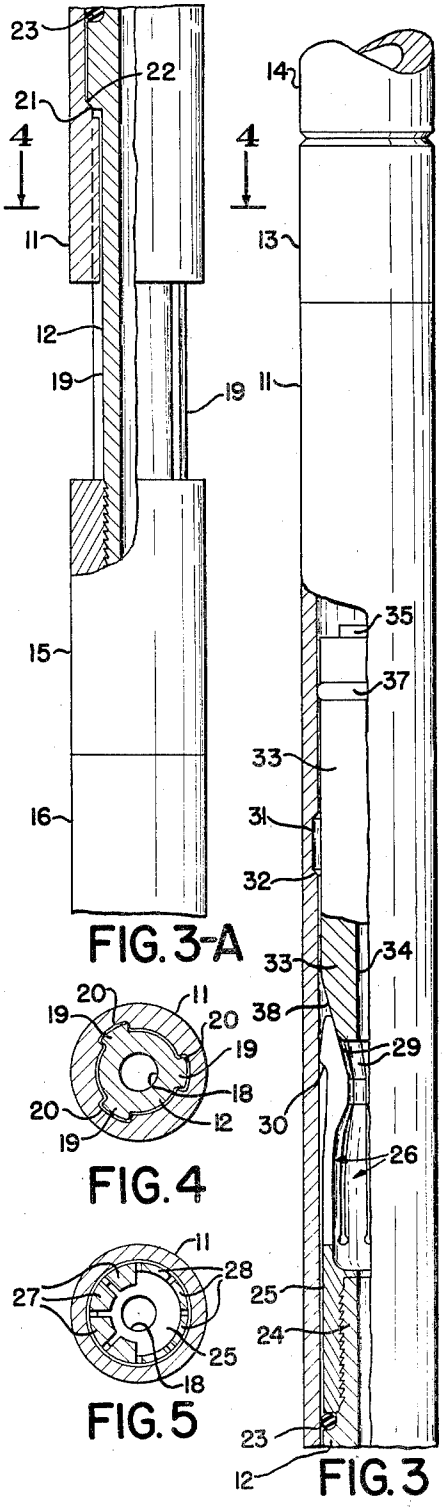


FIG. 3-A

FIG. 3

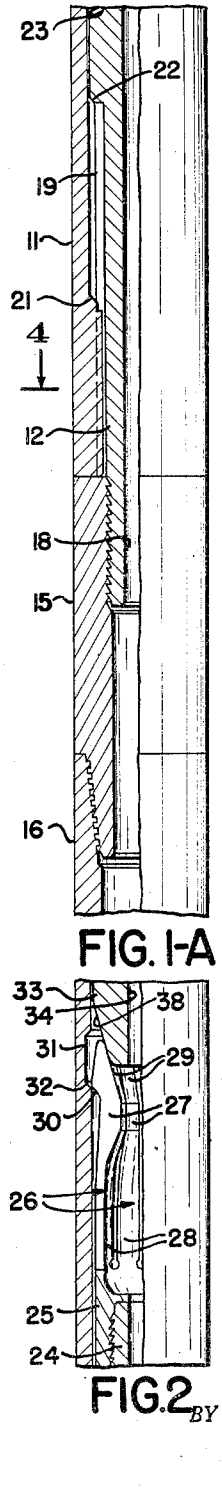


FIG. 1-A

FIG. 2

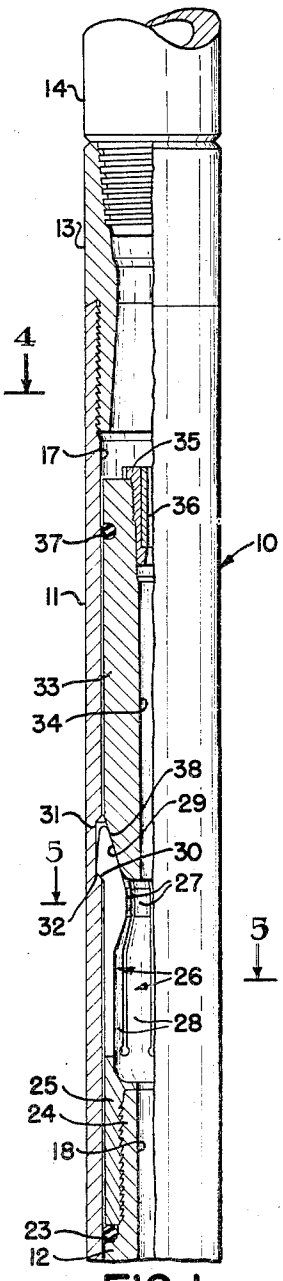


FIG. 1

FIG. 4

FIG. 5

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Patented Apr. 1, 1952

2,591,130

UNITED STATES PATENT OFFICE

2,591,130

JAR

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Application March 24, 1947, Serial No. 736,764

8 Claims. (Cl. 255—27)

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This invention relates to jars for use with drilling and fishing tools and particularly to jars of the "straight pull" type.

Jars of the "straight pull" type are those which conventionally employ a detent type catch between the jar members which is releasable by a straight upward pull applied to the jar members. In such jars it is obviously advantageous to be able to regulate or control the magnitude of the impact force developed by the action of the jar. Various expedients which have heretofore been employed to obtain the desired degree of regulation of the impact force are relatively complicated, entailing expensive construction, or require removal of the tool from the well in order to adjust the control mechanism, or require the insertion into the well of mechanical devices for adjusting the jar mechanism while in place in the well.

The present invention has for its principal object to provide a jar of relatively simple and rugged construction in which the impact force developed may be regulated quickly and positively without removal of the jar from the well.

An important object is to provide a jar employing a fluid pressure operated release mechanism.

A further object is to provide a jar in which a release mechanism is operated by hydraulic pressure of a liquid, such as water, oil or conventional drilling mud, and wherein the impact force developed by the jar may be controlled in a very simple and efficient manner at the top of the well by suitable variation of the pressure of the fluid employed to operate the release mechanism of the jar.

A more specific object is to provide a jar employing a detent-and-shoulder type latch and a fluid-pressure actuated latch holding member to hold the latch elements in releasable engagement under a controllable pressure which will, in turn, determine the tensional force to be applied to the jar members to effect release of the latch and thereby determine the magnitude of the jarring impact which will be developed.

Other and more specific objects and advantages of this invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings which are illustrative of one embodiment in accordance with this invention.

In the drawings:

Figs. 1 and 1–A comprise a longitudinal quarter-sectional view of a jar in accordance with this invention, illustrating the parts of the jar in contracted position;

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Fig. 2 is a fragmentary view in quarter-sectional elevation showing the relative positions of portions of the jar latch elements at the instant of release;

Figs. 3 and 3–A comprise a view similar to Figs. 1 and 1–A showing the parts of the jar in fully extended position;

Fig. 4 is a cross-sectional view along line 4—4 of Fig. 1–A; and

Fig. 5 is a cross-sectional view along line 5—5 of Fig. 1.

Referring to the drawings, the jar in accordance with this invention is designated generally by the numeral 10 and comprises an outer tubular member 11 and an inner tubular member 12 telescopically engaged therewith. The upper end of outer member 11 is connected by means of a conventional tool joint 13 to a string of pipe 14, which may be a special hollow jarring string or a conventional hollow drill stem. The lower end of inner member 12 is similarly connected by means of a tool joint 15 to the stem 16 of a bit, fishing tool, or other device (not shown) connected to the tool or object to be jarred. Members 11 and 12 are provided with axial passageways 17 and 18, respectively, for the passage therethrough of a suitable hydraulic fluid, such as water or the usual drilling mud, which is circulated through the pipe string into which jar 10 is connected. The adjacent lower end portions of members 11 and 12 are provided with a conventional splined connection (see Fig. 4, particularly) consisting of a plurality of angularly spaced splines 19 formed on inner member 12 and cooperating spline grooves 20 cut in the inner wall of outer member 11. Alternatively, the splines may be on member 11 and the grooves on member 12. The splined connection permits relative longitudinal movement between the members but prevents relative rotational movement between them in order that the members may be rotated together as a unit when required. The inner wall of member 11, adjacent the lower end thereof, is provided with an annular shoulder 21 and an adjacent portion of member 12 is provided with an enlargement, at a point above shoulder 21, to form an annular shoulder 22 which is adapted to engage shoulder 21 when the members of the jar are in their extended position. Shoulders 21 and 22 form the jarring abutments which, when caused to strike together, produce the jarring impact which is the primary function of the jar. A suitable and conventional sealing ele-

ment, such as an O-ring 23, is mounted in the outer surface of member 12 above shoulder 22 and is arranged to form a slidable fluid-tight seal between members 11 and 12.

The upper end of member 12 is reduced in diameter and the reduced portion is externally threaded to form a threaded pin connection 24. Screwed on pin connection 24 is a collar 25 which extends upwardly inside member 11 and forms an integral part of jar member 12. The upper portion of collar 25 is slotted longitudinally from its upper edge at a plurality of angularly spaced points to form a corresponding number of angularly spaced latching fingers, designated generally by the numerals 26. The metal forming the upper portion of the wall of collar 25 is made considerably thicker than that forming the lower portion of the collar wall, thereby providing each finger segment with a radially thickened head 27 and a relatively thinner stem 28, this construction being designed to impart a degree of radial flexibility to each of the fingers, which thereby constitute a group of annularly arranged detents carried by the upper end of member 12. The inner surfaces of each of the heads 27 of the fingers are machined to form upwardly and outwardly inclined surfaces 29 and the outer surfaces of heads 27 are under-cut to form outwardly extending shoulders 30 which slope in the same general direction as surfaces 29 although they may incline at a somewhat different angle relative to the axis of collar 25. The outer surfaces of heads 27 above shoulders 30 are machined to an upwardly and inwardly extending taper with the final result that head 27 of each of the fingers is generally wedge-shaped in longitudinal section having its apex at its upper end as illustrated.

The inner wall of member 11 is provided at an intermediate point thereof with an annular groove 31, the lower edge of which is downwardly inclined to complement the slope of shoulders 30 on heads 27 and thereby form a downwardly sloping shoulder 32 for engagement therewith. Groove 31 is positioned in member 11 at a point such that when members 11 and 12 are in their fully contracted position, as illustrated particularly in Fig. 1, shoulders 30 on the finger heads will be engaged with shoulder 32. The outer diameter of the finger heads 27 at the outer edges of shoulders 30 is made somewhat greater than the internal diameter of member 11 so that the fingers must be flexed radially inwardly when inserted inside member 11, whereby when heads 27 of fingers pass shoulders 32 of grooves 31, the heads, by virtue of the spring action of stems 28, will snap into the groove and shoulders 30 will engage shoulder 32 and thereby latch members 11 and 12 together in their contracted position.

Slidably disposed inside member 11 and generally above collar 25 is a tubular plunger 33, which is termed a "wedge," having an axial passageway 34 therethrough which is of substantially the same diameter as passageway 18 through member 12. A choke plug 35, having an axial passageway 36 extending therethrough, is screwed into the upper end of passageway 34. The area of passageway 36 in the choke plug is made less than that of passageway 34 to thereby form a fluid flow restriction in the latter, and, therefore, in the path of fluid which will be caused to flow through the jar members in the operation of the jar, as will be hereinafter described. A suitable sealing element, such as an O-ring 37, is mounted in the outer surface of wedge 33 adjacent its upper end to form a slidable fluid-tight seal between wedge 33 and the inner wall of member 11. The lower end of wedge 33 is provided with a conical tip 38 having a taper which is substantially complementary to surfaces 29 of latching fingers 26. It will be noted that wedge 33 is not connected directly to any other part of the jarring mechanism and, except for the frictional resistance due to O-ring 37, is freely slidable within member 11 relative to the ends of fingers 26. The complementary tapers of tip 38 and surfaces 29 of the latching fingers are designed to permit tip 38 to enter the upper end of collar 25 and apply a wedging action on heads 27 of the fingers, to thereby expand the fingers radially outwardly so as to securely lock heads 27 in groove 31 by engagement of shoulders 30 with shoulder 32, until such time as the wedging pressure is overcome, in a manner to be described, to effect release of the finger heads from groove 31.

The jar will be operated in the following manner when inserted, for example, in a fishing string employed to recover a lost tool which has become lodged in a well: Jar 10 will be connected at its upper end (member 11) to pipe string 14 and at its lower end (member 12) to stem 16 of a conventional fishing tool (not shown). When the string is run into a well, the fishing tool will be firmly attached in the usual manner to the object to be jarred. Upon such attachment the string will be lowered sufficiently to contract the jar members and bring shoulders 30 of finger heads 27 into latching engagement with shoulder 32. Figs. 1 and 1-A illustrate the position of the parts of the jar when the jar members are thus held in contracted position. A suitable pressure fluid such as water, oil or drilling mud, will be pumped from the surface, generally by conventional mud pumps (not shown), down through the interior of the pipe string and jar members, emerging from the string at some suitable point near the lower end thereof and returning, in the usual manner, outside the string to the surface. In flowing through the jar members, the pressure fluid, by virtue of the fluid-tight seals provided by O-rings 23 and 37, will necessarily be forced to flow through restricted passageway 36 in choke plug 35 and thence through passageways 34 and 18 of wedge 33 and member 12, respectively. The flow restriction provided by choke plug 35 will create a back pressure at the upper end of wedge 33 in the stream of fluid passing through the jar. This back pressure will act on the upper end of wedge 33 to propel the latter downwardly inside the bore of member 11 forcing conical tip 38 into the upper end of collar 25 and causing the conical surfaces of tip 38 to wedgingly engage the complementary surfaces 29 of fingers 26. The fluid pressure thus exerted on the upper end of wedge 33 will be transmitted generally radially through surfaces 29 to the engaging shoulders 30 and 32 of the latch elements and will hold these elements in tight engagement under a pressure which will be dependent primarily upon the pressure exerted on the upper end of wedge 33 by the action of the fluid pumps at the surface. Obviously, the total holding force which will be exerted on the latching elements will be determined by the pump pressure, the area of the upper end of wedge 33, and the angles of surfaces 38 and 29 and 30 and 32, but since all of these factors, except the pump pressure, are constant, the pump pressure will determine the magnitude of the holding force

exerted against the latching elements. So long as the force thus exerted on the latching elements exceeds the tensional strain between the jar members, the latching elements will remain in engagement and hold the jar members in contracted position.

When it is desired to release the latch elements so that the jar members may be extended to produce the desired jarring impact between jarring abutments 21 and 22, an upward pull will be taken on pipe string 14 by means of the usual draw-works or other conventional hoisting mechanism (not shown) located at the top of the well. This upward pull will, of course, place a degree of longitudinal strain between jar members 11 and 12 which, to the extent it is resisted by the holding force exerted on the latch elements, will develop tensional stress in the string in which the jar is connected. When the force of the upward pull thus applied to the jarring string exceeds the holding force applied to the latch elements by the fluid pressure exerted through wedge 33, the resulting reactive forces, acting through the engaging surfaces of shoulders 32 and 30 and surfaces 29 and 38, will force wedge 33 to move upwardly sufficiently to allow heads 27 of the latching fingers to slip downwardly off of shoulder 32 and thereby effect dis-engagement of members 11 and 12. This movement will be accompanied by radial inward movement of fingers 26 which is permitted by the described flexible construction thereof. Fig. 2 illustrates the relative positions of the latch elements at the instant of release. Immediately after dis-engagement of the latch elements, the jar members will be pulled apart at high velocity under the tensional force developed between them and in the stretched pipe string in overcoming the holding force on the latch elements, and impact shoulder 21 on member 11 will strike impact shoulder 22 on member 12 with a high-energy upward blow, thereby producing a sharp, upwardly directed, jarring impact on the tool to which the jar is connected. The relative positions of the parts of the jar structure at the moment of impact is illustrated particularly in Figs. 3 and 3-A.

With a jar structure of the kind described, it will be evident that the magnitude of the jarring impact can be effectively regulated and controlled merely by controlling the fluid pressure applied to wedge 33, and that this control can be effected by the very simple expedient of controlling the operation of the fluid pumps at the surface to maintain the desired pressure. By selection of suitable dimensions for wedge 33 and for the angularity of the engaging surfaces of the latch elements, the application of a relatively small pump pressure may be made to produce a very much larger total pressure against the latching surfaces which must be overcome by the tensional force exerted through pipe string 14 to release the latch.

With the device in accordance with this invention, repeated jarring impacts may be produced by lowering the string after each impact to re-engage the latch elements, and then re-applying the upward pull on the string. The magnitude of the several jarring impacts in any series may be varied as desired by suitable variation of the pump pressure as previously described.

It will be understood that various alterations and changes, which will be readily apparent to those skilled in the art to which this invention pertains, may be made in the details of the embodiment herein described within the spirit of this invention but without departing from the scope of the appended claims. For example, by suitable reversal and relatively simple alteration of parts, the principles of the invention herein described may be readily embodied in jars employed to develop downwardly directed impacts. In certain operations wherein it may be unnecessary or undesirable to circulate the pressure fluid entirely through the jar members, fluid passageway 34 and choke plug 35 may be eliminated from wedge 33 and the application of fluid pressure directly against the closed upper end of such a wedge form will produce the same operation as was previously described. It will be understood also, that while the use of a hydraulic fluid is normally to be preferred, pneumatic fluids, such as air or gas, may be substituted therefor without altering the principles or functional results described.

What we claim and desire to secure by Letters Patent is:

1. A jar, comprising, a pair of tubular members telescopically engaged for relative longitudinal movement and adapted to be inserted into a pipe extending into a well bore from the surface, striking abutments carried by said members inter-engageable when said members are in extended position, cooperating latch elements connected with the respective members frictionally engageable when the members are in contracted position, and a holding element independent of said latch elements freely slidable axially in the bore of one of said members by fluid pressure applied from the surface through said pipe into wedging engagement with said latch elements to thereby intensify the holding force on said latch elements, said latch elements being releasable from each other by the application of a degree of longitudinal strain between said members which exceeds the holding force exerted on said latch elements by said holding elements to permit jarring action.

2. A jar, comprising, a pair of tubular members telescopically engaged for relative longitudinal movement and adapted to be inserted in a pipe extending into a well bore from the surface, striking abutments carried by said members inter-engageable when said members are in extended position, cooperating shoulder and detent elements connected with the respective members frictionally engageable when the members are in contracted position, and a holding element comprising a wedge-shaped plunger freely slidable axially in the bore of one of said members by fluid pressure applied from the surface through said pipe into wedging engagement with said detent elements to intensify the force holding said detent elements in engagement with said shoulder, said detent elements being releasable from said shoulder by a degree of longitudinal strain between said members which exceeds the holding force exerted on said detent elements by said plunger to permit jarring action.

3. A jar according to claim 2 wherein said detent elements comprise a plurality of annularly arranged flexible fingers radially expandible into said frictional engagement with said shoulder.

4. A jar, comprising, a pair of tubular members telescopically engaged for relative longitudinal movement and adapted to be inserted in a pipe string extending into a well bore from the surface, striking abutments carried by said members inter-engageable when said members are in extended position, a shoulder element carried by

the outer member, detent elements carried by the inner member frictionally engageable with said shoulder element when said members are in contracted position, a plunger freely slidable within the bore of said outer-member actuable by pressure of a fluid applied thereto through said pipe from the surface to wedgingly hold said detent elements in engagement with said shoulder element whereby to intensify the holding force between said elements, said detent elements being releasable from said shoulder element by a degree of longitudinal strain between said members which exceeds the holding force exerted on said detent elements by said plunger to permit jarring action.

5. A jar, comprising, a pair of tubular members telescopically engaged for relative longitudinal movement and adapted to be inserted in a pipe extending into a well bore from the surface, striking abutments carried by said members inter-engageable when said members are in extended position, a shoulder element carried by the outer member, detent elements carried by the inner member frictionally engageable with said shoulder element when said members are in contracted position, a plunger independent of both said shoulder and detent elements slidably mounted within said outer member above and engageable with said detent elements, a fluid-flow passageway of restricted area through said plunger communicating with the bores of said members and forming a fluid-flow restriction therebetween in the path of a pressure fluid applied thereto through said pipe from the surface whereby to develop an actuating fluid pressure on said plunger, said plunger being actuatable by said fluid pressure to wedgingly hold said detent elements in engagement with said shoulder element, a fluid-tight seal between said members on one side of said engaging elements, and a fluid-tight seal between said plunger and said outer member on the opposite side of said engaging elements, said detent elements being releasable from said shoulder element by the application of a degree of longitudinal strain between said members which exceeds the holding force exerted on said detent elements by said plunger.

6. A jar, comprising, a pair of tubular members telescopically connected for relative longitudinal movement and having a bore for conducting pressure fluid therethrough, striking abutments carried by said members inter-engageable when said members are in relative extended position, cooperating latch elements mounted on the respective members frictionally engageable to normally hold said members in contracted position and releasable by tensional strain between said members which exceeds the engaging force between said elements to thereby permit jarring action, and a latch holding element freely slidable axially of said bore relative to said latch elements, said holding element forming a fluid-flow restriction in said bore whereby to be urged into wedging engagement with said latch elements by pressure exerted by said fluid to thereby intensify the force of said frictional engagement between said latch elements in accordance with the magnitude of said pressure.

7. A jar according to claim 6 wherein said latch holding element comprises a cylindrical plunger having slidable sealing engagement with the wall of said bore.

8. A jar according to claim 6 wherein said latch holding element comprises a cylindrical plunger having slidable sealing engagement with the wall of said bore and has a restricted passageway extending axially therethrough.

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