Nov. 26, 1940. E. BURNS 2,222,646

JARRING TOOL

Filed July 11, 1939 2 Sheets-Sheet 1

Fig. 1

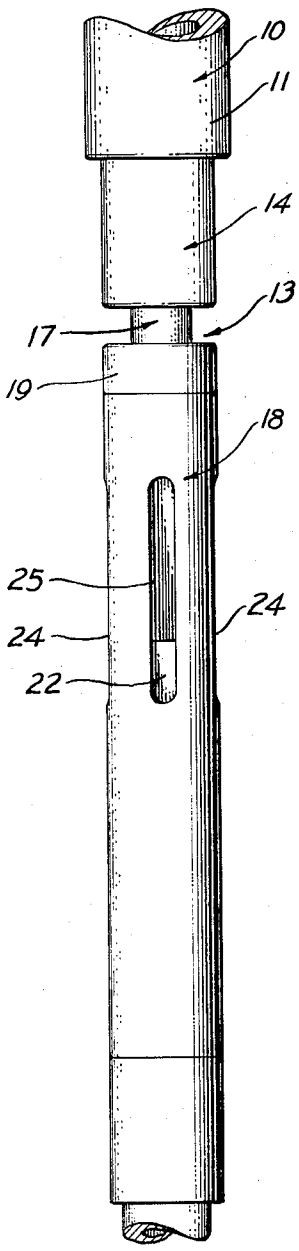
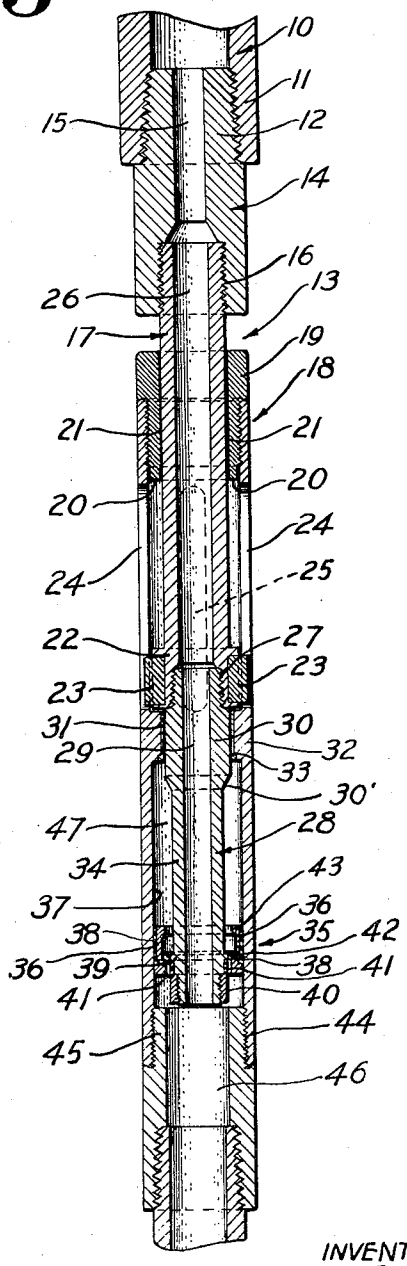


Fig. 2



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Fig. 3

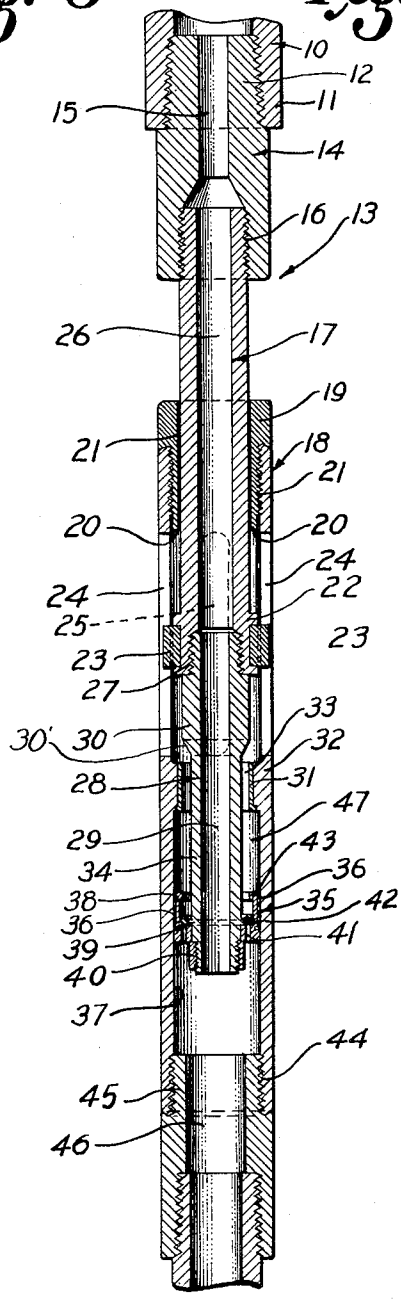
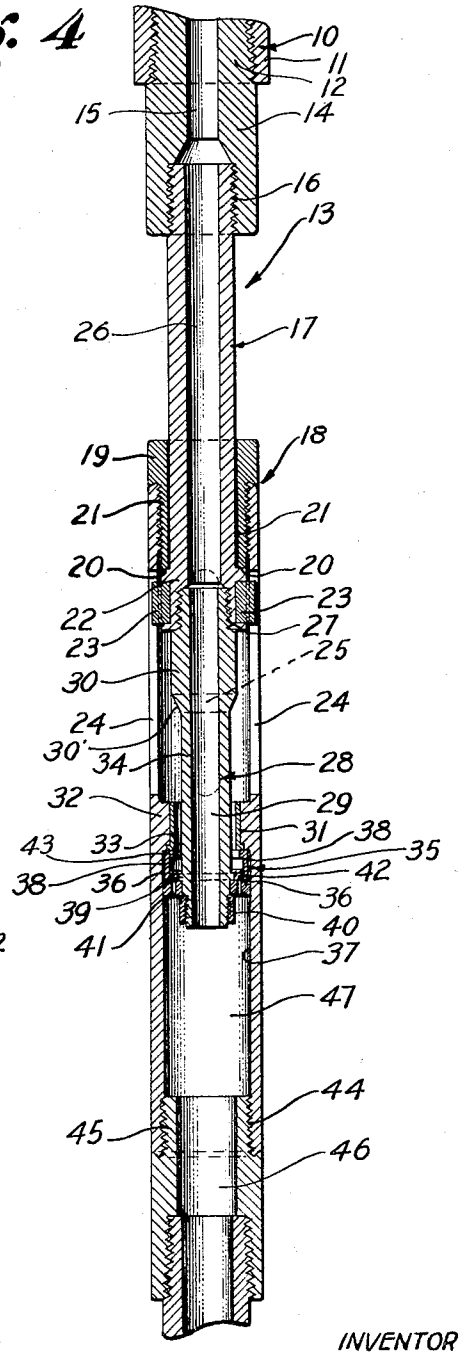


Fig. 4



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UNITED STATES PATENT OFFICE

2,222,646

JARRING TOOL

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Application July 11, 1939, Serial No. 283,823

6 Claims. (Cl. 255—27)

This invention relates to oil well tools and particularly pertains to a jarring tool.

In various drilling operations it often occurs that the drill-string is twisted off in the hole or that some tool becomes accidentally lodged in the hole and must be removed. This is usually accomplished by engaging the lodged object with a fishing tool and then imposing a jarring force to the fishing tool in a manner to act to dislodge the object. Various types of well jars have been designed, some of them operate mechanically and their hammer and anvil sections are held apart and released by mechanical means controlled on the top of the well. Other types of jars have hydraulic action so that when a hydraulic pressure is imposed upon parts of the jar a jarring action will be created and in some instances the jarring parts will be released. In the operation of well jars of hydraulically latched type one of the particular problems is to maintain parts of the jar in a fluid-tight condition, since the pressure exerted upon the fluid producting the latching action is of great magnitude and the hydraulic pressure of the column of fluid within the well and within which the jar is submerged is likewise of great magnitude.

It is the principal object of the present invention, therefore, to provide a well jar of the hydraulically latched type and within which a quantity of drilling fluid from the well is temporarily entrapped to produce a latching action, the said drilling fluid discharging directly back into the well in an unrestricted flow and the moving parts being at all times hydraulically balanced. The present invention contemplates the provision of a well jar including a mandrel section and a barrel section, one of which sections carries an anvil and the other of which sections carries a hammer. The sections are slightly linked together and are provided with an intermediate chamber within which drilling fluid from the well may be entrapped and from which it is discharged by the tension imposed upon the drill-string to permit release of the mandrel and barrel and to produce a blow between the hammer and the anvil in proportion to the magnitude of tension applied to the drill-string at the top of the well.

The invention is illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a view in elevation showing the assembled well jar.

Fig. 2 is a view in central longitudinal section showing the well jar with its parts in their hydraulically latched position.

Fig. 3 is a view in central longitudinal section similar to Fig. 2 showing the well jar with its parts in an intermediate position and at substantially the point at which the jar releases.

Fig. 4 is a view in central longitudinal section showing the jar in its impact position.

Referring more particularly to the drawings, 10 indicates a drill-string which is suspended from suitable means in the derrick of a well and which is here shown as carrying a threaded box 11 at its lower end. Mounted within the box 11 is the pin 12 of a well jar structure, generally indicated at 13. The pin is formed as a part of an upper sub 14 which has a circular passageway 15 therethrough and a threaded counter-bore 16 at its lower end. The threaded counter-bore 16 receives the upper threaded end of a tubular mandrel 17. The mandrel 17 is here shown as extending downwardly through a barrel 18. The upper end of the barrel 18 is fitted with an anvil collar 19 which is threaded onto the barrel and is provided with an anvil face 20. A central passageway 21 is formed through the collar 19 to receive the tubular mandrel 17. The mandrel 17 is formed at its lower end with an enlarged head 22. Secured within the circumferential faces of this head is a pair of diametrically opposed keys 23. The keys 23 extend into slotted openings 24 in the diametrically opposite side walls of the barrel 18. At right-angles to the plane of the openings 24 in the wall of the barrel 18 are slotted openings 25 through which well fluid may pass as will be hereinafter described.

The mandrel 17 is formed with a central circulation bore 26, the lower end of which terminates in a threaded counter-bore 27. The counter-bore 27 receives the threaded end of a continuing mandrel 28. This mandrel has a central circulating passageway 29 through it which permits free flow of fluid at all times. The continuing mandrel 28 is formed with sections of two diameters, an upper section 30 which is of larger diameter and extends through a bushing 31 carried by an inner shoulder 32 of the barrel 18. A slight clearance space 33 exists between the circumferential face of the bore of the bushing and the outer circumferential face of the portion 30 of the mandrel extension 28. Below the mandrel portion 30 is a reduced portion 34. Mounted on the lower end of the portion 34 of the mandrel section 28 is a piston structure. This comprises a metallic cup 35 formed with a cylindrical flange 36. Disposed between the flange 36 and the wall of the bore 37 of the barrel is a packing element 38 which pro-

duces a fluid-tight seal between the cylindrical face of the flange 36 and the cylindrical face of the wall of the bore 37. The lower end of this cup abuts against a shoulder 39 formed on the mandrel extension 28 and it is held in this position by a lock nut 40 which engages the threaded end of the mandrel extension 28. Formed through the end wall of the cup are ducts 41. Resting against the upper ends of these ducts is a valve ring 42 by which the ducts are closed during a certain operation of the jar.

Spaced from the shoulder 39 and overhanging the valve ring 42 is a retaining shoulder 43. This retaining shoulder limits the movement of the valve ring 42 away from its seat. Attention is also directed to the fact that the valve ring has a sliding fit within the cup 36 and that it is guided toward and away from its seated position. The lower end of the valve barrel is internally threaded, as indicated at 44, and receives the threaded end 45 of another drill-string or of a fishing tool connection. Attention is directed to the fact that this member 45 has a central fluid passageway 46 therethrough. Thus at all times a continuous passage of fluid may circulate through the mandrel 17, the mandrel extension 28 and the drill-string sections at the opposite ends thereof.

It will be noted that the bore 37 forms a compartment 47 within which fluid may be entrapped. This entrapment of fluid takes place between the piston element 35 and the shoulder structure 32 when the enlarged portion 30 of the mandrel extends into or through the bore 33 of the bushing 31.

In operation of the present invention the structure is assembled as shown in the drawings. The lower drill-string section 45 may be fitted with a fishing tool and the upper drill-string section 16 may be connected with the draw works of a well rig. The device is then lowered into the well. During this lowering operation the mandrel 17 and the barrel 18 are in a collapsed position and the head 22 of the mandrel section 17 extends downwardly into a counter-bore seat 48 which occurs above the bushing 31. It will be evident that the mandrel and the barrel are held against relative rotational movement by the keys 23 extending into the keyways 24 and that the lower end of the barrel and the lower drill-string section with the fishing tool may be readily manipulated. It is to be understood that circulation is being maintained through the well jar at all times since the passageway 26 of the upper mandrel section 17 communicates with the passageway 29 of the lower mandrel section 28. The passageway 29 is open at its lower end and discharges fluid into the barrel as well as into the lower drill-string section.

When the jar is in its collapsed condition, as particularly shown in Fig. 2 of the drawings, the enlarged portion 30 of the lower mandrel section 28 substantially fills the opening 33 through the bushing 31 and substantially seals the compartment 47 occurring between the barrel and the piston 35. The circulating fluid will at this time pass downwardly through the mandrel and after filling the lower drill-string section will flow upwardly in the passageways 41 of the piston 35. This will lift the valve ring 42 from its sealing position over the upper ends of the ports 41 and permit the compartment 47 to fill with the fluid of the well. It is to be understood also that a similar action will take place when the well jar has been submerged in the column of fluid within a well to a depth greater than the upper end of the compartment 47.

Attention is also directed to the fact that when the well jar is completely submerged in drilling fluid the hydrostatic pressure exerted by the fluid will balance the moving parts of the well jar and the piston 35 at all times since the openings 24 and 25 in the barrel permit free access of drilling fluid to the upper end of the passageway 33 leading to the compartment 44, and direct communication of the compartment 47 with the interior of the drill-string insures that the piston 35 will be in effect moving in a full column of drilling fluid at all times. The only resistance to this movement is the action produced in forcing the fluid from the compartment 47 through the bore 33 during the time that this bore is occupied by the enlarged portion 30 of the mandrel section 28, as shown in Fig. 2 of the drawings.

When a jarring action is to be produced the compartment 47 will be filled with fluid, as previously described, and the parts will be in the position as shown in Fig. 2 of the drawings, at which time the well jar will be in its latched position due to the confined quantity of drilling fluid entrapped within the compartment 47 between the partition 32 and the piston 35. A desired strain is then placed on the drill-string. This strain will act to create stretch in the drill-string. When a predetermined stretch has been placed in the drill-string the upper end of the drill-string is held and the drill-string acts to restore itself to its normal unstretched condition. During this action the barrel 18 is held against movement and the enlarged portion 30 of the mandrel is gradually drawn through the opening 33 in the bushing 31 while the fluid from the compartment 47 is displaced as it is forced through the passageway occurring between the bushing 31 and the enlarged portion 30 of the mandrel. This displacement of fluid is brought about due to the fact that the valve ring 42 is on its seat and closes the ports 41, and that the piston 35 is moving upwardly and acting against the entrapped quantity of drilling fluid within the compartment 47.

When the enlarged portion 30 of the mandrel section 28 moves so that its lower edge 30' is above and in a position of clearance with the bushing 31 then the restricted portion 34 of the mandrel section 28 will be in register with and extending through the bushing 31 to create the relatively large annular passageway 50 which establishes communication between the compartment 47 and the column of fluid in the well bore. The result will be that the existing tension in the drill-string will act violently to pull the mandrel upwardly and will cause the face 22' of the hammer to strike the anvil face 20. This will deliver a blow to the barrel 18, and since the barrel is indirectly connected to the fishing tool a jarring blow will be delivered to the fish.

Attention is directed to the fact that during this rapid and violent movement of the piston 35 it is hydrostatically balanced by the column of fluid within which it is submerged. Thus, it is insured that the upward movement of the piston will be in a fluid under substantially balanced pressure, and that a maximum blow will occur between the hammer and the anvil due to the fact that the fluid will not dampen the action of the hammer as it strikes. If it is desired to relatch the jar the tension is removed from the drill-string so that the piston 35 will settle in the compartment 47 with the result that fluid will flow into the compartment 47 while the mandrel

section 28 is moving downwardly until the enlarged portion 30 is in register with the bushing 31, after which fluid will flow upwardly through the ports 41 in the piston as the valve ring 42 is lifted.

In analyzing the construction of the well jar with which the present invention is concerned and its mode of operation, it will be seen that the problems of providing a packing for the piston which will withstand the action of external hydrostatic pressure as created by the fluid in the well bore is limited since the piston is substantially balanced at all times by the fluid in the well and merely withstands the excess pressure produced during the compression stroke while displacing the drilling fluid from the compartment 47 through the bushing 31 and around the enlarged mandrel section 30. It will also be seen that few moving parts are required, none of which are subjected to excessive wear, and that there is no problem involved in maintaining a fluid seal for a separate isolated volume of incompressible fluid as is present in other types of hydraulically locked jars. It is also apparent that since all of the moving parts are constantly submerged within the drilling fluid in the well and that the drilling fluid is free to flow through all of these parts in flow and counter-flow, that there is no possibility for the well jar to "sand up" and its parts become thus abraded and worn.

It will thus be seen that the invention here disclosed comprises a well jar structure involving the use of a minimum number of moving parts, none of which are subjected to excessive and detrimental wear, and which jar may be readily latched and released while operating in the drilling fluid and by the use of drilling fluid within which it is submerged.

While I have shown the preferred form of my invention as now known to me, it will be understood that various changes may be made in combination, construction and arrangement of parts by those skilled in the art, without departing from the spirit of my invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A hydraulic well jar comprising a barrel, a tubular mandrel reciprocating therein, said barrel and mandrel being capable of attachment to drill-string sections whereby a continuous fluid circulation may take place through the drill-string sections, the mandrel and the barrel, a fluid entrapment space within the barrel in communication with the fluid circulating through the drill-string, a restricted passageway at the upper end of said fluid space and in constant communication with the fluid within which the jar is submerged and through which passageway the mandrel reciprocates, and an enlarged portion on said mandrel adapted to register with said passageway when the mandrel and barrel are in collapsed position with relation to each other and whereby a restricted annular orifice will be formed through which fluid may be displaced from the entrapment space as tension is exerted between the barrel and mandrel.

2. A hydraulic well jar comprising a barrel, a tubular mandrel reciprocating therein, said barrel and mandrel being capable of attachment to drill-string sections whereby a continuous fluid circulation may take place through the drill-string sections, the mandrel and the barrel, a fluid entrapment space within the barrel in communication with the fluid circulating through the drill-string, a restricted passageway at the upper end of said fluid space and in constant communication with the fluid within which the jar is submerged and through which passageway the mandrel reciprocates, an enlarged portion on said mandrel adapted to register with said passageway when the mandrel and barrel are in collapsed position with relation to each other and whereby a restricted annular orifice will be formed through which fluid may be displaced from the entrapment space as tension is exerted between the barrel and mandrel, and anvil members carried by the barrel and mandrel and adapted to strike each other when the enlarged portion of the mandrel has been retracted from register with the communicating pasageway to the entrapment space.

3. A hydraulic well jar comprising a barrel, a tubular mandrel reciprocating therein, said barrel and mandrel being capable of attachment to drill-string sections whereby a continuous fluid circulation may take place through the drill-string sections, the mandrel and the barrel, a fluid entrapment space within the barrel in communication with the fluid circulating through the drill-string, a restricted passageway at the upper end of said fluid space and in constant communication with the fluid within which the jar is submerged and through which pasageway the mandrel reciprocates, an enlarged portion on said mandrel adapted to register with said passageway when the mandrel and barrel are in collapsed position with relation to each other and whereby a restricted annular orifice will be formed through which fluid may be displaced from the entrapment space as tension is exerted between the barrel and mandrel, and anvil members carried by the barrel and mandrel and adapted to strike each other when the enlarged portion of the mandrel has been retracted from register with the communicating passageway to the entrapment space, the space occurring between the hammer and anvil faces being at all times in free communication with the well bore.

4. A hydraulic well jar comprising a barrel, a tubular mandrel reciprocating therein, said barrel and mandrel being capable of attachment to drill-string sections whereby a continuous fluid circulation may take place through the drill-string sections, the mandrel and the barrel, a fluid entrapment space within the barrel in communication with the fluid circulating through the drill-string, a restricted passageway at the upper end of said fluid space and in constant communication with the fluid within which the jar is submerged and through which passageway the mandrel reciprocates, an enlarged portion on said mandrel adapted to register with said passageway when the mandrel and barrel are in collapsed position with relation to each other and whereby a restricted annular orifice will be formed through which fluid may be displaced from the entrapment space as tension is exerted between the barrel and mandrel, anvil members carried by the barrel and mandrel and adapted to strike each other when the enlarged portion of the mandrel has been retracted from register with the communicating passageway to the entrapment space, and check valve means acting to permit a by-pass of fluid around the piston as the piston moves to the collapsed position of the jar and to prevent said by-pass as the piston moves toward its impact position.

5. A hydraulic well jar comprising a barrel, a tubular mandrel reciprocating therein, said barrel and mandrel being capable of attachment to

drill-string sections whereby a continuous fluid circulation may take place through the drill-string sections, the mandrel and the barrel, a fluid entrapment space within the barrel in communication with the fluid circulating through the drill-string, a restricted passageway at the upper end of said fluid space and in constant communication with the fluid within which the jar is submerged and through which passageway the mandrel reciprocates, an enlarged portion on said mandrel adapted to register with said passageway when the mandrel and barrel are in collapsed position with relation to each other and whereby a restricted annular orifice will be formed through which fluid may be displaced from the entrapment space as tension is exerted between the barrel and mandrel, anvil members carried by the barrel and mandrel and adapted to strike each other when the enlarged portion of the mandrel has been retracted from register with the communicating passageway to the entrapment space, check valve means acting to permit a by-pass of fluid around the piston as the piston moves to the collapsed position of the jar and to prevent said by-pass as the piston moves toward its impact position, and inter-engaging means between the mandrel and the barrel whereby said members are locked against relative rotational movement and are free to move longitudinally with relation to each other.

6. A hydraulic well jar adapted to be interposed between tubular lengths of drill-string, which jar includes a tubular mandrel connected to one length of said drill-string and a tubular barrel within which it reciprocates and which is connected to the other length of drill-string, a fluid entrapment chamber formed in the barrel, a piston carried by the mandrel and reciprocating within said chamber, means permitting a free circulation of fluid through the drill-string, the mandrel and the barrel and into the fluid entrapment chamber on one side of the piston, means permitting a free circulation of fluid through the barrel and to the well bore whereby the piston will be substantially fluid-balanced at all times, said last named means including a restricted opening within the barrel from the entrapment chamber to the exterior thereof, and an enlarged portion upon the mandrel adapted to register with said restricted passageway when the jar is in its collapsed position and whereby a relatively small annular space will occur between the wall of the passageway and the surface of said enlarged mandrel portion and through which fluid may be displaced from said entrapment chamber to the well bore under tension created between the barrel and the mandrel.

ERWIN BURNS.