Dec. 6, 1955 O. J. McCULLOUGH 2,725,820

EXPLOSIVE JARRING DEVICE

Filed Nov. 8, 1950

Fig. 1

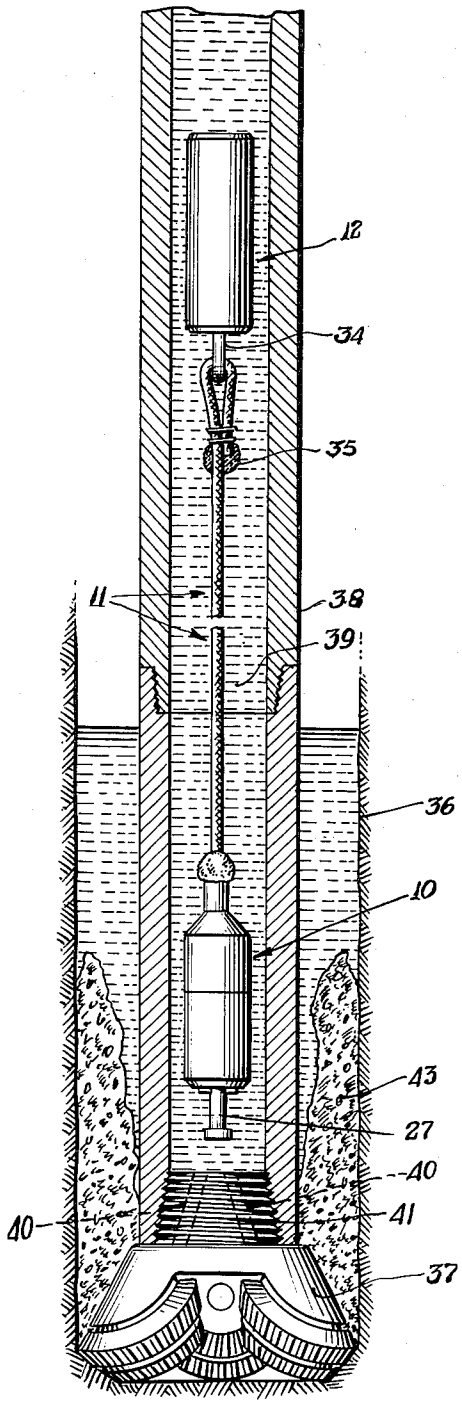


Fig. 2

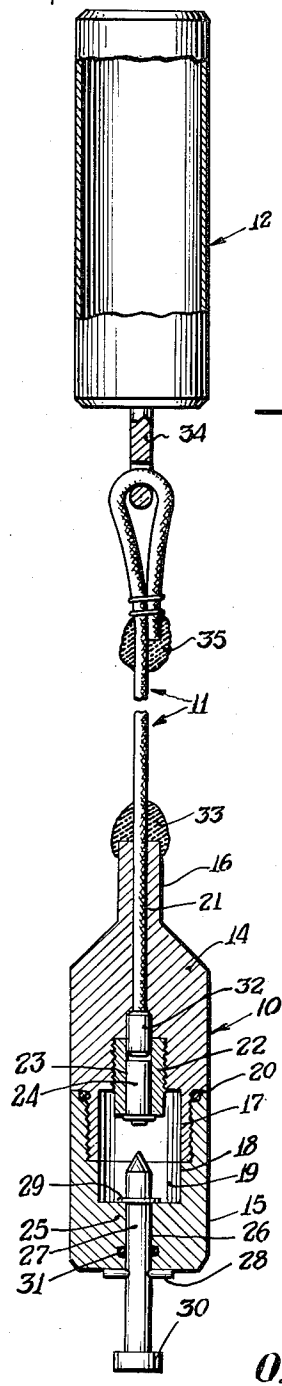


Fig. 4

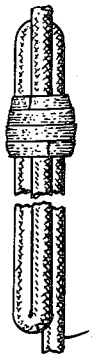
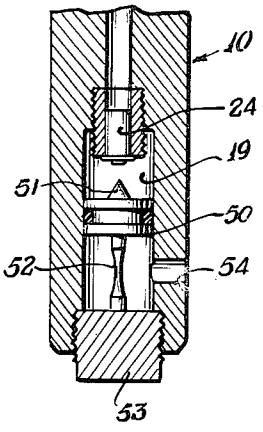


Fig. 3



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United States Patent Office 2,725,820
Patented Dec. 6, 1955

2,725,820

EXPLOSIVE JARRING DEVICE

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Application November 8, 1950, Serial No. 194,600

3 Claims. (Cl. 102—20)

This invention relates to a jarring device for loosening or releasing pipe which has become stuck in a well, and particularly to an explosive type jarring device for this purpose.

In conventional rotary drilling, a tubular drill stem carrying a bit at its lower end is rotated to cut the well bore and fluid is circulated through the bore of the drill stem and bit passages into and through the annular space between the wall of the well bore and the drilling string to wash out the drill cuttings, plaster the wall of the well bore, etc. During the course of such drilling, the drilling string is continuously subject to becoming stuck in the well bore, due to caving of the walls, settling of drill cuttings about the bit and various other causes. The most common danger results from settling of the cuttings about the bit shank, particularly when the circulation of drilling fluid and rotation of the string must be interrupted to add pipe sections to the drilling string or to withdraw the string from the well bore. As the bit is normally larger in diameter than the balance of the drilling string, a shoulder or enlargement will necessarily be present adjacent the point of connection of the bit shank to the drill stem, and this shoulder provides lodgment for cuttings, wall cavings and other detritus, which, if allowed to accumulate sufficiently will cause the drill bit to become anchored or stuck in the well bore so that it cannot be withdrawn.

Such accumulation of detritus about the upper end of the drill bit is a progressive phenomenon and the accumulation usually will rapidly become increasingly large and more consolidated if prompt action is not taken to remove the accumulation or free the bit from its sticking action, with the result that the bit will become increasingly firmly stuck so that it cannot be withdrawn from the well. This will necessitate breaking or cutting the drill pipe as close as possible to the point where the sticking occurs, followed by a difficult and expensive fishing job to remove the bit and clear the well bore for further drilling.

Since sticking of the drill strings most often occurs immediately adjacent the bit, generally as a result of relatively small accumulations of detritus about the bit shank, it is found that it will very often be possible to free the bit by applying a sharp jarring or shaking action to the portion of the string adjacent the bit and the area of the accumulation, particularly if such jarring action is applied promptly after sticking first occurs and before the accumulation becomes very large or strongly consolidated.

Heretofore, various jarring tools have been employed in rotary strings, which generally comprise a relatively complicated tool composed of relatively movable parts which is installed as a part of the rotary string, and is operated usually by appropriate manipulation of the drilling string to produce the desired jarring action, which is primarily an axial impact. Such conventional jarring tools are relatively expensive to construct and as they introduce moving parts into the drilling string, may become broken or jammed, with resulting ineffectiveness in

performing their designed function. Also the design of such tools almost always introduces a restriction in the bore of the drilling string which cuts down the free circulation of drilling fluid through the string.

The present invention has for its primary object the provision of a relatively simple jarring device which obviates the principal disadvantages of existing jarring tools.

A principal object is to provide an explosive type jarring device which may be introduced into the bore of the drilling string when and as required, particularly as soon as sticking occurs, to apply a jarring or shaking action in the drill string adjacent the point at which it has become stuck.

Another object is the provision of a jarring device insertable in the bore of the drilling string and employing a flexible string-type explosive body adapted to extend longitudinally through the bore of the portion of the drilling string to which the jarring force resulting from detonation of the explosive body is to be applied.

A more specific object is the provision of a jarring device insertable in the bore of a drilling string and employing a flexible string-type explosive body, attached at its lower end to a weighted head carrying a percussion type detonator and connected at its upper end to a float adapted to buoyantly support the explosive body in extended position in the fluids normally present in the bore of the drilling string.

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 illustrate useful embodiments in accordance with this invention.

In the drawings:

Fig. 1 is a longitudinal, partly sectional, view of a well bore and a drilling string showing the manner in which the jarring device in accordance with this invention may be employed for jarring the string;

Fig. 2 is a longitudinal, partly sectional, view of the jarring device in accordance with one embodiment of this invention;

Fig. 3 is a fragmentary view illustrating a modification of initiating elements employed for setting off the explosive element; and

Fig. 4 shows a detail of a modified arrangement of the explosive element employed in the jarring device.

Fig. 2 of the drawings illustrates the details of a jarring device in accordance with one embodiment of this invention. The device includes a head member, designated generally by the numeral **10**, which is connected to the lower end of strand of flexible cord-type explosive element **11**, the upper end of which is connected to a buoyant float element **12**. The parts of the device are shaped and dimensioned to be readily insertible in the bore of a drilling string.

Head member **10** is a generally cylindrical body constructed of steel, lead or other heavy metal sufficiently heavy to cause the device to sink rapidly through the drilling fluid normally circulated through the bore of a drilling string. Head **10** is composed of upper and lower sections **14** and **15**, respectively. Upper portion **14** is provided with an upwardly extending portion **16** of reduced diameter, and an externally threaded hollow tubular boss **17** extending from the lower end thereof and concentric with the longitudinal axis of the head. Lower portion **15** has an internally threaded socket **18** into which boss **17** is screwed to connect the two sections of the head together and form a closed hollow chamber **19** within the body. A packing ring **20** is arranged between the inter-engaged threaded portions of boss **17** and socket **18** to seal the threaded connection against leakage of fluid from outside the head into chamber **19**. A narrow axial passageway **21** extends through upper section **14** and

communicates with chamber 19. The lower end of passageway 21 is enlarged in diameter to receive a threaded tubular bushing 22, having a bore 23 which is adapted to receive a percussion-type explosive blasting cap 24, of generally conventional form, which is inserted into bore 23 from the lower end thereof, to fire upwardly toward passageway 21. Lower end wall 25 of lower head section 15 is provided with an axial passageway 26, in which is slidably mounted a firing pin 27 registering with cap 24. Firing pin 27 is normally maintained in retracted position relative to cap 24 by means of a shear pin 28 which extends transversely through the body of firing pin 27 exteriorly of end wall 25. A suitable lock ring or lug 29 is carried by the inner end of firing pin 27 to prevent its complete retraction from head section 15. The outer end of firing pin 27 is provided with an enlarged head 30 and a packing ring 31 is circumferentially arranged between firing pin 27 and the wall of passageway 26 to form a fluid-tight seal between the firing pin and passageway 26.

Explosive element 11, may be any suitable flexible cord-type explosive such as the well known Primacord, such as that manufactured by the Ensign-Bickford Company, Simsbury, Conn., which, generally speaking, is composed of a hollow fabric or plastic tube, the bore of which is filled with one of the well known detonatable chemical explosives such as pentaerythritoltetranitrate, which may be fired by applying a detonating shock at one end, the detonating wave travelling sufficiently rapidly through the length of the cord to produce substantially simultaneous detonation throughout the whole length of the explosive comprising the cord.

One end of element 11 is inserted into passageway 21 in juxtaposition to the discharge end of cap 24. A pellet 32 of any suitable booster explosive may be inserted in passageway 21 between the ends of element 11 and cap 24 to intensify the detonating shock transmitted from the explosion of cap 24 to the end of the explosive cord. An adhesive plastic seal 33, of any suitable type, is arranged about the point of entry of element 11 into extension 26 to form a fluid-tight seal about the outer end of passageway 24 and to fasten element 11 to head 10. The opposite end of element 11 is connected in any suitable manner to a bail 34 carried by the lower end of float 12. The end of element 11 may be connected to the float by looping it through bail 34 and tying the end to the main portion of element 11 in the manner illustrated. The exposed end of element 11 is sealed by enclosing it in a mass of a suitable water-repellant plastic material 35 in the manner shown.

Float 12 may be a closed hollow metal casing, as illustrated, or may be constructed of any other suitable buoyant material, such as wood, plastic or the like. It should be designed to possess a degree of buoyancy sufficient only to support the weight of explosive element 11 without offering serious resistance to the sinking of the device as a whole in the fluid which may be present in the bore of the pipe string in which it is to be inserted. The purpose of float 12 is to maintain element 11 in fully extended position while the device is passing downwardly through the fluid in the drill pipe and, particularly, when it attains the position therein at which the explosion of element 11 is to be effected.

Fig. 1 illustrates the manner in which the above described device may be employed. There is shown a well bore 36 being drilled by a conventional rotary bit 37 driven by a hollow drill pipe 38 which extends to the surface and through which drilling fluid 39 is circulated down through the bore of the drill pipe and through passages 40 provided in bit shank 41 of the bit. Bit shank 41 provides the usual means for connecting the bit to drill pipe 38 and also forms an internal stop in the bore of the drill pipe at a point closely adjacent the bit. When sticking of the bit occurs, as by accumulation of detritus 43 on the upper outer surfaces of the bit and the adjacent portion of the drill pipe, the driller will insert the jarring device, above described, into the bore of the drill pipe at the surface. The weight of head 10 will cause the device to sink rapidly through fluid 39, explosive element 11 being held in extended position by the resistance offered by the buoyancy of float 12 in fluid 39. When the downwardly extending end of firing pin 27 strikes the end of bit shank 41, the inertia of head 10 will break shear pin 28 and drive the inner end of firing pin 27 into percussive contact with cap 24. The latter will then be fired, exploding element 11 and creating a sharp explosive shock in the interior of the drill pipe portion through which element 11 extends. This sudden explosion will produce a sharp jarring or shaking action of the bit and adjacent portion of the drill pipe which will effectively loosen or dislodge detritus 43 sufficiently to free the bit and allow it to be withdrawn from the well.

By reason of its construction and mode of operation, it will be evident that the jarring device in accordance with this invention can be run with a minimum of delay after sticking has occurred so that it can be used effectively to free the bit before there is any substantial opportunity for the detritus to accumulate in large quantity or to become strongly consolidated.

The amount of explosive necessary to produce the desired degree of jarring action will be insufficient to damage the drill pipe, so that the device may be safely used in the manner described. The length of explosive element 11 may be made as long or as short as desired to impart the jarring action to any desired length of the drill pipe. If a jarring shock of increased intensity is desired, element 11 may be formed in a plurality of strands by forming the desired number of loops in element 11 and tying the loops together in the manner illustrated in Fig. 4.

Fig. 3 illustrates a modified form of firing arrangement by which element 11 may be fired by hydrostatic pressure in the drilling string. This modification may be employed in instances where it is desired to jar the pipe at some point above its lower end where no abutment is present by which the design shown in Fig. 2 could be effectively set off.

In the modification shown in Fig. 3, chamber 19 forms a piston chamber in which is mounted a slidable piston 50, carrying on its upper end a firing pin 51 registering with blasting cap 24. Piston 50 is connected by means of a link 52 to a screw plug 53 which forms a closure for the outer end of chamber 19. A port 54 is provided in the wall of chamber 19 below piston 50 whereby fluid outside head member 10 may enter chamber 19. Link 52 is designed to rupture when the pressure applied to the lower face of piston 50 reaches some predetermined value. With this arrangement, the jarring device may be dropped into the drill pipe and when it has sunk into the fluid to a depth at which the hydrostatic pressure, exerted on the lower face of piston 50 by the fluid entering chamber 19 through port 54, attains the rupture point of link 52, the latter will break and the pressure of the fluid on the piston will drive the latter upwardly, thereby driving firing pin sharply against cap 24, and setting-off the explosive element. By appropriate selection of the rupture strength of link 52, the device can be made to fire at any desired position along the interior of the drill pipe where it is desired to produce the jarring action.

Various other firing mechanisms may be used to set off the explosive body. For example, cap 24 may be of the well known electrically fired type connected to a battery and timing mechanism installed in chamber 19. Such time controlled electrical firing mechanism for setting off explosive charges are well known in the well shooting art.

It will be evident that devices constructed in accordance with this invention may be employed in other applications where it is desired to produce an explosion in selected portions of a well bore filled with liquid. It

may be employed in an open bore hole or inside a pipe string inserted in the bore hole.

It will be understood that various alterations and changes may be made in the details of the illustrative embodiments herein described within the scope of the appended claims but without departing from the spirit of this invention.

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

1. An explosive jarring device insertible in a well pipe or a well bore, comprising, an explosive body of the flexible cord type, a buoyant member connected to the upper end of said explosive body, a weighting member connected to the lower end of said explosive body, said weighting member having a chamber enclosed therein, a passageway through the upper end of said weighting member communicating with said chamber, said lower end of said explosive body extending into said passageway, an explosive percussion cap disposed in said passageway in detonating relation to said lower end of said explosive body, and a firing pin movably mounted in said chamber and adapted to be driven against said cap.

2. An explosive jarring device insertible in a well pipe or a well bore, comprising an explosive body of the flexible cord type, a buoyant member connected to the upper end of said body, a weighting member connected to the lower end of said body, said weighting member having a chamber enclosed therein, a pasageway through the upper end of said weighting member communicating with said chamber, said lower end of said explosive body extending into said passageway, an explosive percussion cap disposed in said passageway in detonating relation to said lower end of said explosive body, a firing pin movably extending through the lower end of said weighting member to the exterior thereof, frangible means normally maintaining said firing means in retracted relation to said cap and

breakable by impact of said weighting member against an abutment in said well pipe or bore to drive said firing pin against said cap.

3. An explosive jarring device insertible in a well pipe or well bore, comprising, an explosive body of the flexible cord type, a buoyant member connected to the upper end of said body, a weighting member connected to the lower end of said body, said weighting member having a chamber enclosed therein, a passageway through the upper end of said weighting member communicating with said chamber, said lower end of said explosive body extending into said passageway, an explosive percussion cap disposed in said pasageway in detonating relation to said lower end of said explosive body, a piston slidable in said chamber, a firing pin mounted on said piston in registration with said cap, a link member connecting said piston to the lower end of said chamber to normally hold said piston in retracted position relative to said cap, said link being rupturable by pre-determined fluid pressure applied to the lower end of said piston, and a port in the wall of said chamber below said piston.

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