Dec. 14, 1943. L. SPENCER 2,336,812

FIRING MECHANISM FOR GUN PERFORATORS

Filed Oct. 12, 1942

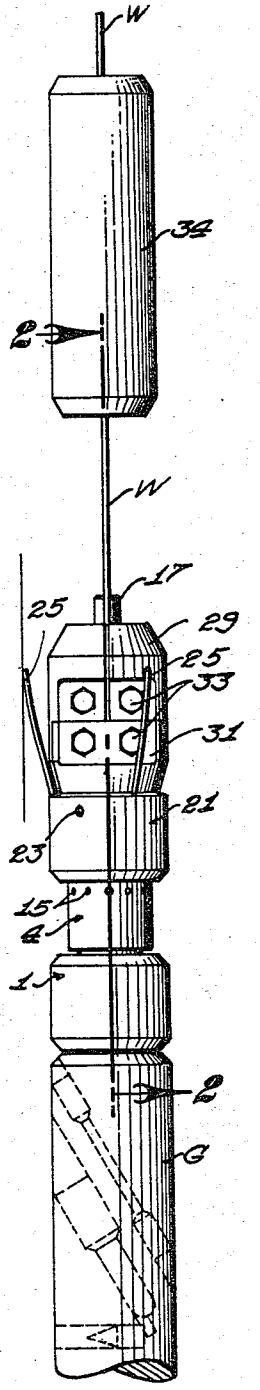


FIG. 1

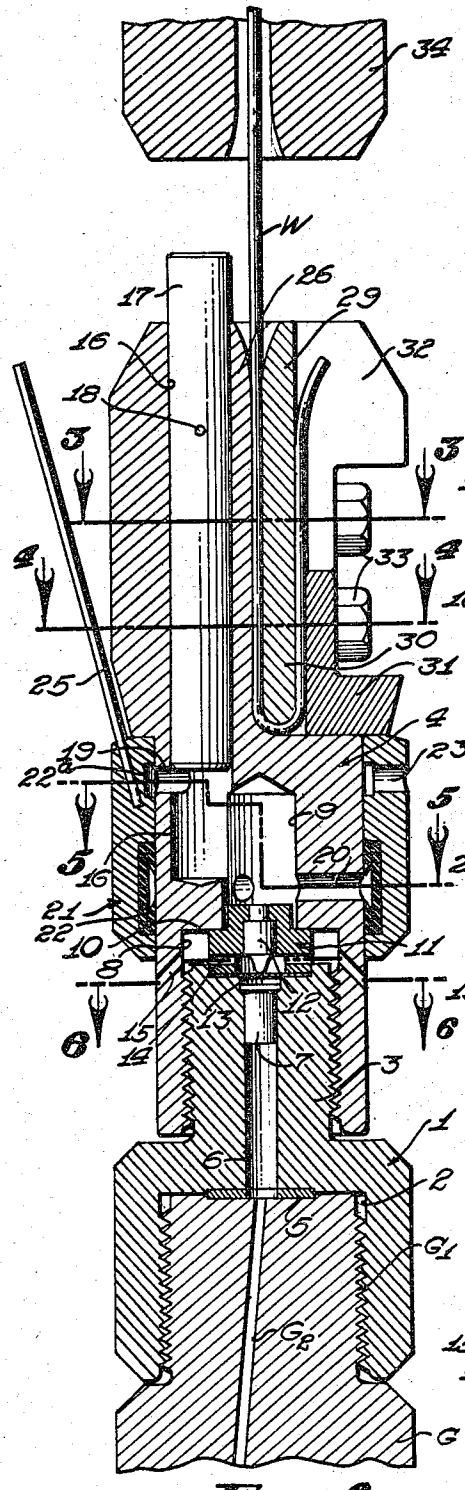


FIG 2

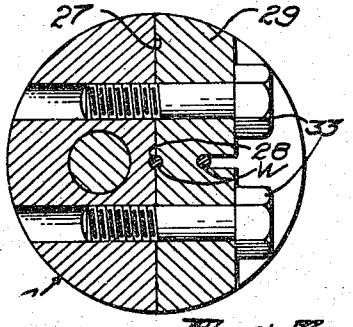


FIG. 3

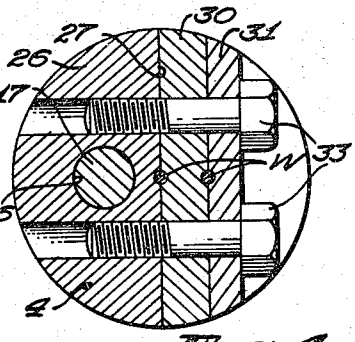


FIG. 4

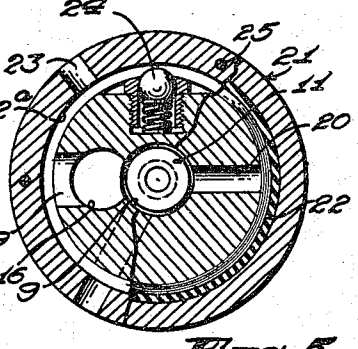


FIG. 5

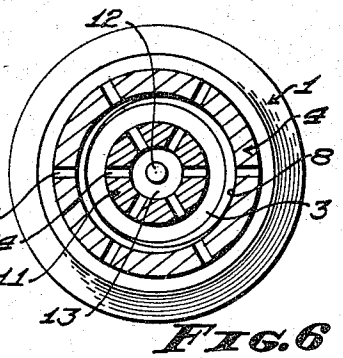


FIG. 6

INVENTOR

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Patented Dec. 14, 1943 2,336,812

UNITED STATES PATENT OFFICE

2,336,812

FIRING MECHANISM FOR GUN PERFORATORS

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Application October 12, 1942, Serial No. 461,817

13 Claims. (Cl. 164—0.5)

My invention relates to firing mechanisms for gun perforators, and among the objects of my invention are:

First, to provide a firing mechanism for gun perforators which forms a connecting head between a cable or wire line and a gun perforator and which is actuated by a tubular go-devil dropped down the cable or wire line;

Second, to provide a firing mechanism for gun perforators which is inherently safe in that the firing mechanism is inoperative unless submerged in a liquid and, further, becomes inoperative once the gun perforator is raised in the well bore whether submerged or not;

Third, to provide a firing mechanism for gun perforators which is particularly adapted for attachment to a single strand wire line, the firing mechanism incorporating a novel clamp means for such wire line; and

Fourth, to provide a firing mechanism which is adapted for use in conjunction with the gun perforator disclosed in my copending applications, Serial No. 455,259 filed August 18, 1942, and Serial No. 459,461 filed September 23, 1942.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawing, in which:

Figure 1 is an elevational view of my firing mechanism shown attached to a wire line and to a gun perforator, and showing also a go-devil before it engages the firing mechanism;

Figure 2 is an enlarged longitudinal sectional view of my firing mechanism taken through 2—2 of Figure 1; and

Figures 3, 4, 5 and 6 are transverse sectional views thereof taken through 3—3, 4—4, 5—5 and 6—6, respectively, of Figure 2.

The gun perforator G with which my firing mechanism is intended to be used may take the form of the disclosures in the aforementioned copending patent application, or any type of gun perforator may be employed which is provided with a threaded upper end G1 and an ignition passage G2 intersecting the upper end of the gun perforator.

An adaptor 1 forms the lower end of my firing mechanism. The adaptor is provided with a socket 2 at its lower end which screw-threads to the upper end of the gun perforator and is provided with a stem 3 which screw-threads to a cable head body 4. A seal is effected between the upper end of the gun perforator and the inner end of the socket 2 by means of a gasket 5. The stem 3 is provided with a longitudinally extending cartridge bore 6 which communicates with the ignition passage G2. The upper end of the cartridge 7 which may be a conventional cartridge bore receives a blank rifle or pistol cartridge containing the conventional detonator.

The cable head body 4 is provided with a socket 8 which receives the stem 3. Continuing upwardly from the socket 8 is a chamber 9 of smaller diameter forming a shoulder 10. A firing pin holder 11 is clamped between the shoulder 10 and the upper end of the stem 3. The holder is in the form of a short cylinder and is provided with a central opening which receives a small firing pin 12. Interposed between the holder and the upper end of the stem 3 is a sealing plate 13 which closes the upper end of the cartridge bore 6 to exclude water therefrom. The plate is however capable of being pressed inwardly or broken by the firing pin 12, as will be described in more detail hereinafter. Clearance is provided around the lower end of the firing pin and suitable bleeder ports 14 and 15 in the holder and in the side walls of the socket 8 communicate between this region and the exterior of the cable head body.

The firing pin holder seals the lower end of the chamber 9. The chamber 9 is intersected by an eccentrically located longitudinally extending firing plunger bore 16 which extends upwardly through the cable head body to the upper end thereof and receives a firing plunger 17, which is initially held in an upper position by means of a small shear pin 18. In this position the upper end of the firing plunger projects above the cable head body. Immediately below the normal or upper position of the plunger the firing plunger bore 16 is intersected by a filler port 19. Immediately above the lower end of the chamber 9 there are provided laterally extending drain ports 20.

The lower portion of the cable head body is preferably reduced in diameter and receives a slidable collar 21 having an internal channel in which is fitted a seal ring 22 which in its normal or upper position covers the drain ports 20, the combined areas of which are preferably in excess of the area of the piston 17. It is desirable that the filler port under such conditions be exposed to well fluid. Consequently, a channel 22a and port 23, or other means, may be provided at the upper end of the collar 21 to provide access. The channel 22a may be utilized to receive a ball clutch 24 set in the body member and which normally restrains the collar in its upper position. The collar 21 is provided with upwardly diverging cage fingers 25 which may be formed of soft

wire. These fingers permit downward movement of the gun and firing mechanism in a well casing, but catch against the casing when the firing mechanism is raised, forcing the collar 24 downwardly; they are sufficiently yieldable that they will double back on themselves upon continued upward movement of the firing mechanism without placing too much strain on the supporting cable or wire line.

The upper end of the cable head body is notched to form a semi-cylindrical portion 26 through which the firing plunger bore 16 extends. Said portion forms a vertical diametrically extending wall 27 in which is formed a wire groove 28 adapted to receive a wire line W, in this case shown as a single conductor steel wire. The upper portion of the vertical wall or face 27 of the semi-cylindrical portion 26 is covered by a clamp block 29 which is complementary thereto and is provided with a downwardly extending stem or tongue 30 which is provided with a groove not only on its inner side adjacent the vertical wall 27, but also at its lower and outer side, the lower end of the tongue being rounded so that the wire may be bent therearound as shown in Figure 2. The tongue 30 receives a clamp member 31 which is likewise complementary. The clamp block and clamp member are secured to the semi-cylindrical portion 26 by bolts 33 extending on opposite sides of the wire line and the firing plunger. The clamp block may be provided with a slot 32 continuing from the groove in the tongue 30 for the purpose of accommodating the free end of the wire W.

The upper end of the firing plunger 17 is positioned so that it may be engaged by the lower end of a go-devil 34 which is tubular so that it may be dropped down the wire line.

Operation of my firing mechanism is as follows: When the firing mechanism is lowered with a gun perforator into an oil well the parts are in the position shown in Figure 2. As soon as the firing mechanism submerges in the liquid contained in the well the liquid fills in the chamber 9 through the port 19. When the desired level is reached the go-devil is dropped and strikes the firing plunger 17, shearing the pin 18. As soon as the plunger descends far enough to close the filler port 19 the impact shock of the go-devil against the plunger is transmitted through the liquid in the chamber 9 to the firing pin 12, driving it against a detonator contained in the cartridge 7. The bleeder ports 14 and 15 allow the liquid to escape from under the firing pin as it is driven down, and the seal ring 13 prevents escape of liquid from the chamber 9.

It is obvious that the firing mechanism can not operate unless it is full of liquid, and consequently can not be discharged accidentally unless submerged in liquid.

After the gun has been fired the first upward movement causes the collar 24 to assume its lower position, indicated by dotted lines in Figure 2, by reason of engagement of the fingers 25 with the surrounding well casing, particularly if these fingers catch into a joint. The fingers are made of small soft steel wires so that they readily double backward and do not interfere with removal of the gun and firing mechanism. When the collar 24 is in its lower position the drain ports 20 are uncovered. These ports are relatively large and not only serve to drain the liquid from the chamber once the gun is above the liquid level, but also render the firing mechanism inoperative when the collar is in its lower position for they tend to dissipate the force that would otherwise be transmtited to the firing pin from the firing plunger.

If it is desired to fire the gun in a dry well, the chamber 9 and connecting openings may be filled with liquid, or with a semi-solid such as grease.

There is little danger of accidental engagement of the firing plunger during descent of the gun perforator; however, the go-devil sometimes "hangs up" on the supporting member due to a "dog leg" or bend in the casing, then during upward movement of the gun perforator the go-devil may free itself and fall. In the event of the latter, more common occurrence, the firing mechanism is disarmed for once the gun perforator is raised in the well bore the drain ports 20 are uncovered and the contents of the chamber 9 can no longer function to transmit an appreciable shock from the firing plunger 17 to the firing pin 12, but instead passes freely out of the drain ports 20 and upwardly to fill the space previously occupied by the upper end of the plunger 17. This transfer of liquid causes no change in the total volume of liquid in and surrounding the cable head; consequently, the hydrostatic pressure due to the liquid in which the gun is submerged has no effect. If, as it is intended, the total area of the holes 19 is relatively large in comparison with the area of the plunger 17 there is very little resistance offered to the displacement of the liquid from the bottom to the top of the plunger 17, and therefore there is practically no force available to actuate the firing pin 12.

While a semi-solid or semi-liquid substance may be substituted for a true liquid in the liquid chamber, such material in operation functions as a liquid. Therefore, the term as herein used is intended to include such semi-solids or semi-liquids. Furthermore, well temperatures are relatively high, often above the boiling point of water, so that substances such as paraffin, which are actually solid at ordinary temperatures, may fill the chamber, being poured therein while hot. Use of such normally solid substances provides an added safety feature inasmuch as the firing mechanism can not operate until the material has melted or materially softened by the heat of the well. Again, the term liquid as herein used is intended to apply to such normally solid material which becomes sufficiently liquid under operating conditions.

Various changes and alternate arrangements may be made within the scope of the appended claims, in which it is my intention to claim all novelty inherent in the invention.

I claim:

1. A firing mechanism for gun perforators, comprising: a detonator; a firing pin adapted to engage said detonator; a firing plunger; means defining cylinders for said pin and plunger, wherein said pin and plunger form pistons for liquid, and a liquid chamber connecting said cylinders; and means for striking said plunger whereby movement of said plunger transmits through liquid, if any, in said liquid chamber force to the firing pin.

2. A construction as set forth in claim 1 which includes further: drain ports for said chamber; a closure for said ports; and means for moving said closure from a position closing said ports to a position exposing said ports.

3. The combination with an explosively operated well tool and a suspension line, of a firing

mechanism attached to said line and supporting said well tool, comprising: a body member defining a liquid chamber; a pair of liquid piston and cylinder means communicating with said cylinder, one of said pistons forming a firing pin positioned for engagement with a detonator, the other of said pistons forming a firing plunger protruding from said body member; and a go-devil for striking said firing plunger.

4. The combination with an explosively operated well tool and a suspension line, of a firing mechanism attached to said line and supporting said well tool, comprising: a body member defining a liquid chamber; a pair of liquid piston and cylinder means communicating with said cylinder, one of said pistons forming a firing pin positioned for engagement with a detonator, the other of said pistons forming a firing plunger protruding from said body member; a go-devil for striking said firing plunger; drain ports communicating with said chamber, and a collar slidable on said body member from a position covering said ports to a position exposing said ports; and means engageable with a surrounding casing for so moving said collar when said firing mechanism is raised in the well bore.

5. A firing mechanism for gun perforators, comprising: a firing pin; a firing plunger; an arming device for operatively connecting said pin and plunger, including means defining a chamber communicating with said pin and piston; and a liquid filling said chamber to transmit movement of said plunger to said pin.

6. A firing mechanism for gun perforators, comprising: a firing pin; a firing plunger; an arming device for operatively connecting said pin and plunger, including means defining a chamber communicating with said pin and piston; a liquid filling said chamber; and means for draining said chamber of its liquid to render said plunger ineffective.

7. A firing mechanism for gun perforators, comprising: a cartridge chamber; a cartridge including a detonator; a seal member covering said cartridge to exclude liquids; a firing pin positioned adjacent said seal member and adapted to be driven into said seal member to set off said detonator; a firing plunger; and a liquid column operatively connecting said plunger and firing pin.

8. A firing mechanism for gun perforators, comprising: a cartridge chamber; a cartridge including a detonator positioned in said chamber; a seal member covering said cartridge to exclude liquids; a firing pin positioned adjacent said seal member and adapted to be driven into said seal member to set off said detonator; a firing plunger; and means defining a liquid chamber communicating with said pin and plunger, said liquid chamber adapted, when said firing mechanism is submerged in a liquid, to fill with said liquid and whereby the liquid forms a fluid connection between said pin and plunger.

9. A firing mechanism for gun perforators, comprising: a cartridge chamber; a cartridge including a detonator positioned in said chamber; a seal member covering said cartridge to exclude liquids; a firing pin positioned adjacent said seal member and adapted to be driven into said seal member to set off said detonator; a firing plunger; means defining a liquid chamber communicating with said pin and plunger, said liquid chamber adapted, when said firing mechanism is submerged in a liquid, to fill with said liquid and whereby the liquid forms a fluid connection between said pin and plunger; and means for draining said chamber whereby said pin and plunger are inoperatively associated when said firing mechanism is not submerged in water.

10. A firing mechanism for gun perforators, comprising: a cartridge chamber; a cartridge including a detonator positioned in said chamber; a seal member covering said cartridge to exclude liquids; a firing pin positioned adjacent said seal member and adapted to be driven into said seal member to set off said detonator; a firing plunger; means defining a liquid chamber communicating with said pin and plunger, said liquid chamber adapted, when said firing mechanism is submerged in a liquid, to fill with said liquid whereby the liquid forms a fluid connection between said pin and plunger; a by-pass port communicating with said liquid chamber; and a closure, including means engageable with a surrounding casing to restrain said closure over said by-pass port during downward movement of the firing mechanism and to move said closure clear of said ports during upward movement of the firing mechanism.

11. A firing mechanism for gun perforators, comprising: a cartridge chamber; a cartridge including a detonator positioned in said chamber; a seal member covering said cartridge to exclude liquids; a firing pin positioned adjacent said seal member and adapted to be driven into said seal member to set off said detonator; a firing plunger; means defining a liquid chamber communicating with said pin and plunger, and also defining ports of sufficient area to dissipate substantially any force transmitted to liquid in said chamber by said firing plunger; a closure for said ports adapted, when closing said ports, to cause the force of said firing plunger to be transmitted through liquid contained in said chamber to said firing pin; and means engageable with a surrounding casing to move said closure clear of said ports.

12. A firing mechanism for gun perforators, comprising: a firing pin; a firing plunger; an arming device for operatively connecting said pin and plunger, including means defining a chamber communicating with said pin and piston, and a normally solid material having the characteristics of a liquid at the temperatures encountered in a well bore and filling said chamber to transmit movement of said plunger to said pin.

13. A firing mechanism for gun perforators, comprising: a firing pin; a firing plunger; an arming device for operatively connecting said pin and plunger, including means defining a chamber communicating with said pin and piston, a normally solid material having the characteristics of a liquid at the temperatures encountered in a well bore and filling said chamber to transmit movement of said plunger to said pin, said chamber having a by-pass port and a closure for said port; and means engageable with a surrounding casing to move said closure clear of said by-pass port when said firing mechanism is raised in a well bore.

LLOYD SPENCER.