

Aug. 28, 1956

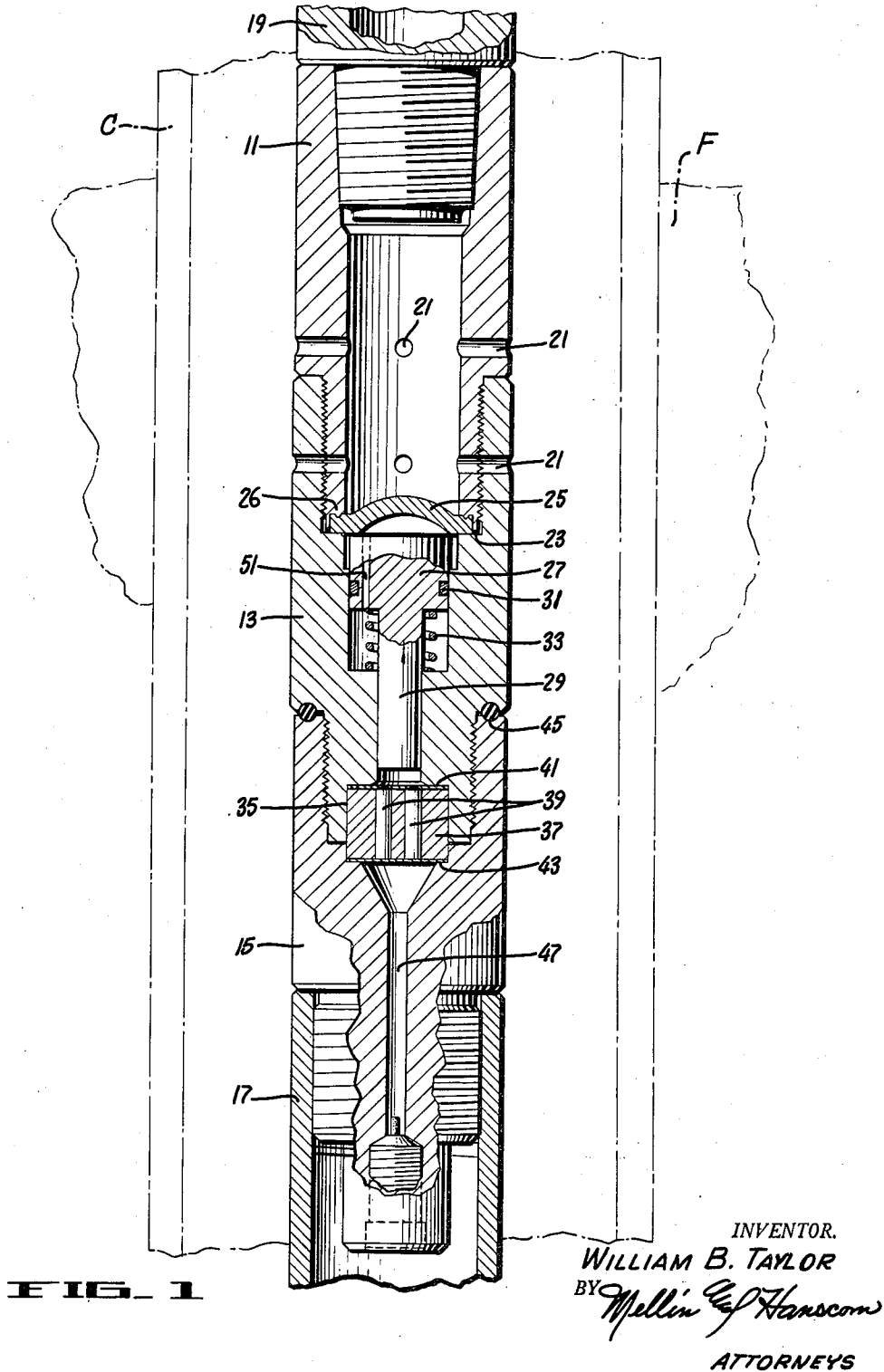
W. B. TAYLOR

2,760,408

FIRING HEAD

Filed May 19, 1953

4 Sheets-Sheet 1



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W. B. TAYLOR

2,760,408

FIRING HEAD

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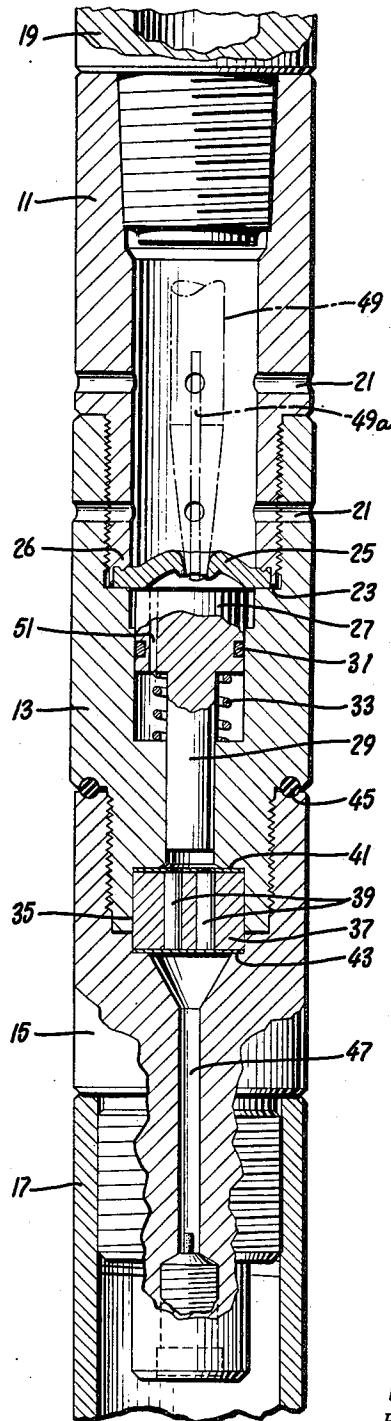


FIG. 2

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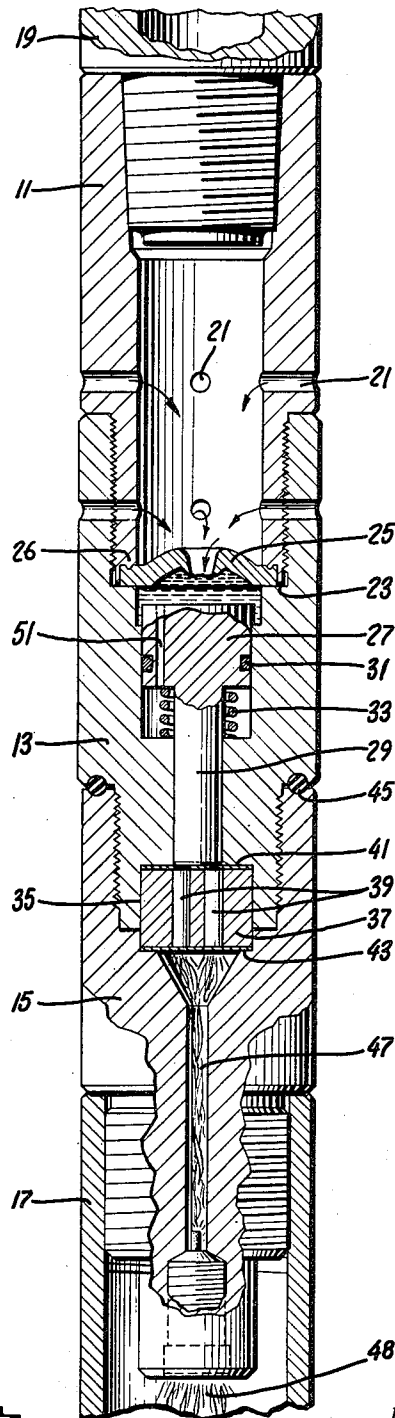
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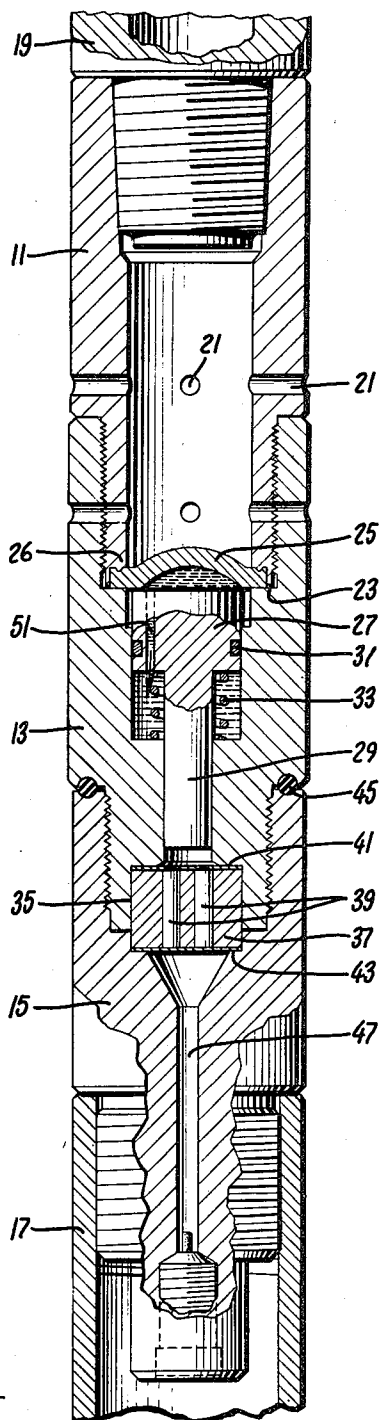
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FIG. 4



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2,760,408

FIRING HEAD

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Application May 19, 1953, Serial No. 355,899

5 Claims. (Cl. 89—1)

This invention relates to oil well equipment and particularly to a perforating gun firing head employed in firing the charges of a perforating gun.

In my copending application entitled Method of Completing Oil Wells, Serial No. 355,900, filed May 19, 1953, there is disclosed a method of completing an oil well including the steps of lowering a perforating gun into an oil well on the lower end of a string of tubing into registry with a selected production formation, replacing the mud fluid in the well with oil by circulating oil downwardly through the tubing, outwardly through a passage above but adjacent the perforating gun, and upwardly through the space between the tubing and the casing, thereafter closing the space between the tubing and casing, thereafter firing the gun to perforate the casing and the surrounding production formation, and then permitting formation fluid from the production formation to flow into the above-mentioned passage and upwardly through the tubing to the surface past a valve controlled opening in the tubing at the surface. Since the tubing is filled with fluid at the time it is desired to fire the perforating gun, attempts at firing the gun by employing a go-devil, functioning as a percussion element, have not proved successful because the fluid in the tubing buoys up the go-devil by an amount equivalent to the fluid displaced by the go-devil, thus lessening the downward velocity of the go-devil through the tubing, said fluid also acting as a cushioning medium to prevent sharp impact between the go-devil and a firing pin or equivalent element on the firing head. Although an electrically fired type firing head may be employed in carrying out my method described in the above-entitled copending application, this would entail the use of at least one long electrical lead, and a special construction of the tubing to accommodate this lead.

It is a main object of the present invention to provide a perforating gun firing head adapted to be lowered into a well bore, a string of casing or tubing containing fluid, as a part of a perforating gun and conditioned for firing by a go-devil dropped down the well and actually fired by the pressure of the fluid in the well.

A more particular object of the present invention is to provide a perforating gun firing head including a tubular firing head body adapted to be connected to the charged carrier of a perforating gun and adapted to be lowered into an oil well which is occupied by fluid under hydrostatic head, the tubular body having a passage opening into the upper end of the bore of said body for admitting well fluid, said body containing a piston slidably disposed within the bore of the tubular body at a place below said passage, a rupturable or frangible seal closing the bore at a place between the passage and the piston so as to free the piston from the force of the hydrostatic head of the fluid in the well and the tubing, a detonable fuse means beneath the piston adapted to be detonated by the piston when the piston is driven downwardly into sharp contact therewith, and means holding the piston out of engagement with the detonable fuse means responsive, when the seal is broken and the hydrostatic head of the fluid in the

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well and the tubing becomes effective on the piston, to permit downward movement of said piston.

Another object of the present invention is to provide a firing head as described in the immediately above paragraph wherein there is an orifice-type passageway communicating at its opposite ends with the space between the piston and the seal and the space beneath the piston, to prevent fluid, which may leak past the seal, from building up pressure above the piston and causing premature firing of the detonable fuse means.

Various other objects of the present invention will be apparent from the following description taken in connection with the accompanying drawings wherein:

Fig. 1 is a longitudinal mid-sectional view through a firing head employing the concepts of the present invention, the parts being depicted in their running-in condition.

Fig. 2 is a view similar to Fig. 1, but showing the parts after rupture of the seal, but before firing of the detonable fuse means.

Fig. 3 is a view similar to Fig. 2, but showing the parts after the piston has been driven downwardly and caused detonation of the detonable fuse means.

Fig. 4 is a view similar to Fig. 1, but showing how fluid, which leaks past the seal, by-passes the piston.

Although the firing head of the present invention has been especially designed to be connected to a lower end of a string of tubing to enable carrying out of some of the steps of the method described in my copending application, above identified, the invention is not intended to be limited to this use, since the concepts of my present invention may be employed in other installations and the firing head may be supported by other means.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, there is disclosed a perforating gun including a firing head comprising a composite tubular firing head body including a top sub 11, a middle sub 13, and a bottom sub 15 suitably threadedly connected together in end-to-end relation. Bottom sub 15 is formed for attachment to the charged carrier 17 of the perforating gun. Top sub 11 is formed for attachment to a string of tubing 19 by which the perforating gun may be lowered into a well. Formed through the walls of top and middle subs 11 and 13 are passageways 21 providing communication between the interior of the head and the fluid in the well. The connection between top sub 11 and middle sub 13 provides a shoulder 23 upon which is supported an upwardly convex frangible sealing disc 25 held in place and pressed against the shoulder by the lower end 26 of said top sub. Slidably disposed within middle sub 13 is a piston 27 having a reduced stem 29 depending therefrom, the piston and stem being disposed within upper and lower bores formed in the middle sub which substantially agree in diameter with said piston and stem, respectively, as is apparent from the drawings.

Piston 27 is provided with an external annular groove receiving a resilient O-ring seal 31 which sealingly engages the walls of the bore within which the piston rides. Disposing the piston in engagement with disc 25 is a strong compression spring 33 surrounding stem 29.

At its lower end, middle sub 13 is counterbored to receive a detonable fuse means generally entitled 35 fitting in said counterbore and within a counterbore formed in the upper end of bottom sub 15. Fuse means 35 includes a cartridge cylinder 37 and cartridges 39. Above and below the cylinders 37 are disc washers 41 and 43, respectively, the detonable fuse assembly being clamped between the middle and top subs as shown in Fig. 1. Cartridges 39 are of the type which are sensitive to shock and thus when piston 27 is driven downwardly so that the stem thereof

is driven into contact with the detonable fuse means 35, the cartridges are detonated by the resulting shock.

A resilient O-ring seal 45 is received in opposed annular grooves provided in the opposed ends of middle and bottom subs 13 and 15 to prevent fluid from leaking inwardly between the middle and bottom subs and coming into contact with detonable fuse means 35.

Bottom sub 15 is provided with a flash bore 47 extending from the detonable fuse means 35 downwardly to the central passage 43 of the charged carrier 17 to cause detonation of the charges of the carrier upon firing of cartridges 39.

In operation, when it is desired to fire the perforating gun, a go-devil, such as indicated at 49, is dropped down the tubing and gravitates through the fluid within the tubing into engagement with the frangible sealing disc 25 to rupture the same and hence allow the hydrostatic head of the fluid in the well and in the tubing to be effective against piston 27 to drive the same downwardly to cause sharp contact between stem 29 and fuse means 35 to cause detonation of the cartridges. The flash flame thus created travels down flash bore 47 to fire the charges in the carrier in any conventional manner. Go-devil 49 has suitable grooves 49a or similar elements to provide space between the go-devil from the interior walls of tubing 19 to permit ready passage of displaced fluid upwardly through the tubing as the go-devil travels downwardly therethrough. The lower end of the go-devil is downwardly tapered so as not to block inward flow of formation fluid through passages 21 and also to provide more or less point contact between the go-devil and frangible disc 25.

Although frangible disc 25 is normally securely held in place and functions as an effective seal, occasionally because of manufacturing tolerances, carelessness in assembling the parts, et cetera, the seal is not held tightly in place and hence fluid under the influence of the hydrostatic head in the well does leak past said disc. To prevent a pressure buildup above piston 27, which would tend to cause premature contact between the piston stem and the detonable fuse means, an orifice 51 is formed in the piston to communicate between the space above the piston and below the disc and the space below the piston. Hence, under the above circumstances, the fluid pressures on the upper and lower sides of piston 27 are equalized and the piston remains in its elevated condition and no premature firing occurs. In fact when leakages occur, no firing at any time can occur. However, if there is no fluid leakage past disc 25, when the disc is broken, the orifice cannot equalize the pressures on the opposite sides of the piston because of the suddenness of the subjection of the piston to the fluid, and hence the piston is driven downwardly in the manner previously described.

Although the specific form of the invention disclosed is especially adapted to be lowered into the well by a string of tubing, it is apparent that the firing head is also adapted to be lowered into a well on a wire line. In such a construction, a go-devil could be dropped down the wire line into engagement with a disc breaker to rupture the disc and break the seal.

By the present invention, a novel firing head has been provided wherein the head is adapted to be fired by the employment of the force of the hydrostatic head of the fluid in the well and conditioned for firing by a go-devil dropped down the well.

While I have shown the preferred form of my invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

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

1. A firing head, comprising a tubular firing head body adapted to be lowered into an oil well which is occupied by fluid under hydrostatic head, said tubular body having a passage opening into the upper end of the bore of said body for admitting the well fluid, a piston slidably disposed within the bore of the tubular body at a place below said passage, a rupturable seal closing the bore at a place between the passage and the piston so as to free the piston from the force of the hydrostatic head of the fluid in the well, detonable fuse means beneath the piston adapted to be detonated by the piston when the piston is driven downwardly into sharp contact therewith, means holding the piston out of engagement with the detonable fuse means, said means being responsive when the hydrostatic head of the fluid in the well suddenly becomes effective on the piston to permit downward movement of said piston, and a restricted passage in said piston providing communication between the spaces above and below said piston whereby, when the seal is broken, the hydrostatic head of the fluid in the well suddenly becomes effective on the piston to force the same downwardly into sharp contact with the detonable fuse means to fire the same, and whereby any fluid which might leak into the space above said piston prior to the rupturing of said seal will bypass through said restricted passage and prevent premature firing of the device.

2. A firing head, comprising a tubular firing head body adapted to be lowered into an oil well on the lower end of a tubular string which is occupied by fluid under hydrostatic head, a piston slidably disposed within the bore of the tubular body, a rupturable seal closing the bore at a place above the piston so as to free the piston from the force of the hydrostatic head of the fluid in the tubing, detonable fuse means beneath the piston adapted to be detonated by the piston when the piston is driven downwardly into sharp contact therewith, means holding the piston out of engagement with the detonable fuse means, said means being responsive when the hydrostatic head of the fluid in the tubing suddenly becomes effective on the piston to permit downward movement of the piston, and a restricted passage in said piston providing communication between the spaces above and below said piston whereby, when the seal is broken, the hydrostatic head of the fluid in the tubing suddenly becomes effective on the piston to force the same into sharp contact with the detonable fuse means to fire the same, and whereby any fluid which leaks into the space above said piston prior to the rupturing of said seal will bypass through said restricted passage and prevent premature firing of the device.

3. A device as defined by claim 1, wherein the means for holding the piston out of engagement with the detonatable fuse is a strong compression spring.

4. A device as defined by claim 1, wherein the seal is a frangible disc adapted to be broken by a go-devil dropped through the tubular string.

5. A device as defined in claim 1, wherein the means for holding the piston out of engagement with the detonatable fuse is a strong compression spring, and the seal is a frangible disc adapted to be broken by a go-devil dropped through the tubular string.

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