March 10, 1959 T. L. LONG 2,876,701

FIRING HEAD

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Fig-1

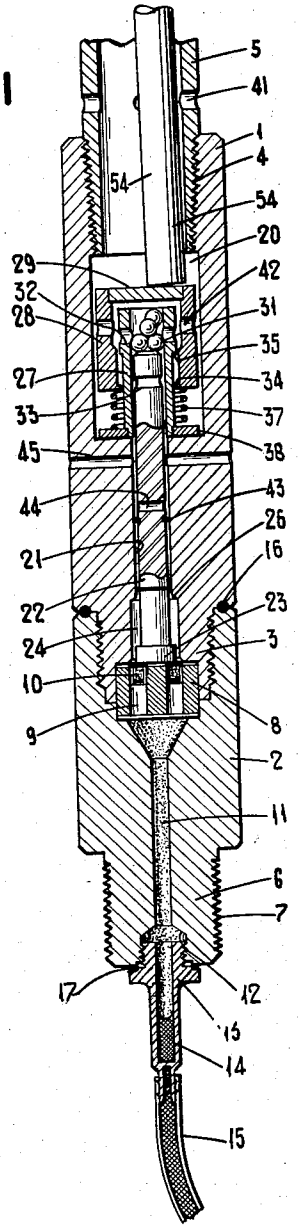


Fig-2

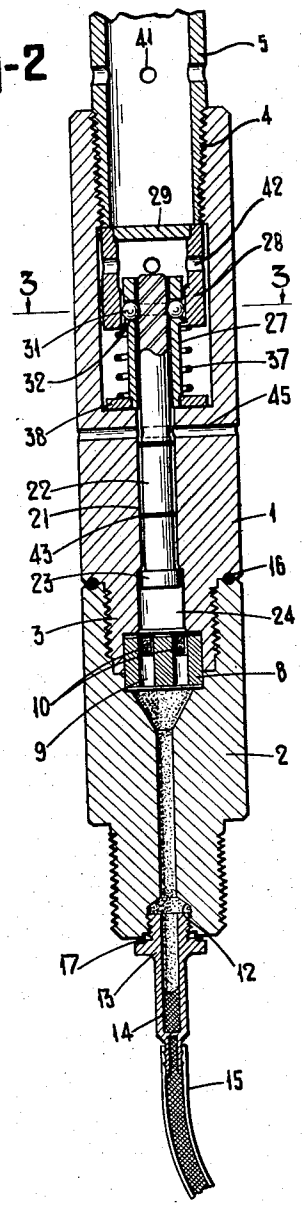
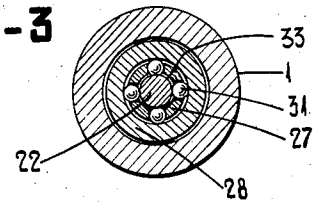


Fig-3



INVENTOR.
THOMAS L. LONG

BY
Mellin and Hanscom
ATTORNEYS

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FIRING HEAD

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Fig-4

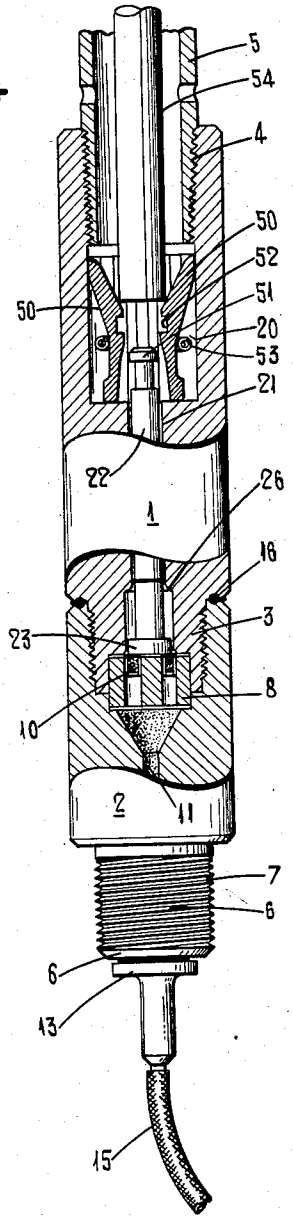


Fig-5

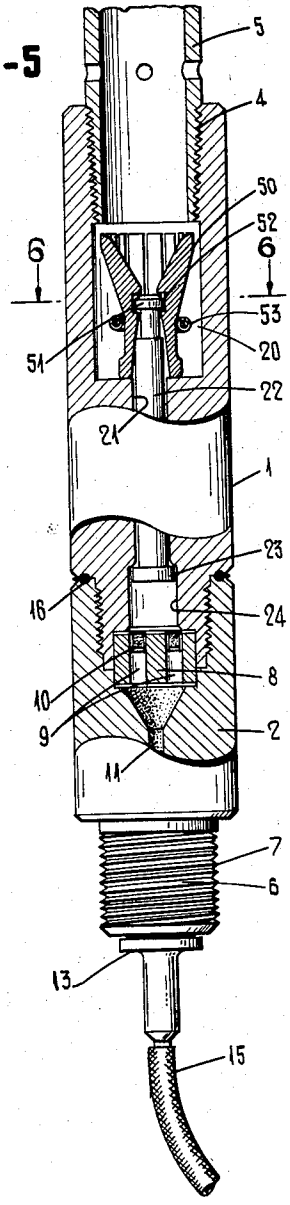
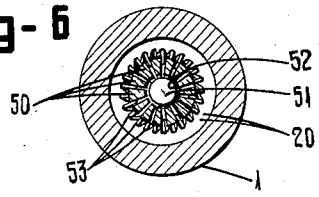


Fig-6



INVENTOR.
THOMAS L. LONG

BY

Meclin and Hanscom
ATTORNEYS

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2,876,701

FIRING HEAD

Thomas L. Long, Houston, Tex., assignor to Johnston Testers, Inc., Houston, Tex., a corporation of Texas

Application January 11, 1954, Serial No. 403,334

1 Claim. (Cl. 102—70)

This invention relates to the perforating of well casings in oil wells, and particularly to a firing head for discharging the perforating elements of a perforating gun.

It is among the objects of the present invention to provide a simple and dependable mechanism for discharging the perforating elements carried by a perforating gun when the gun has been lowered to a desired depth in a well.

Another object is to provide a firing head constructed as a unit which is readily connectable between a string of pipe and a perforating gun lowered thereby into a well casing, and operable by means of a go-devil introduced into the string of pipe from the top of the well.

Another object is to provide a firing head in which detonating means is effectively sealed into a firing head provided with a firing pin normally held in a cocked position, and releasable to permit its actuation by hydraulic pressure to detonate a firing charge.

A further object of the invention is to provide improved structure devised to facilitate the assembly and operation of the device, and to increase the efficiency and dependability of the device for its intended purposes.

The invention has other objects and features of advantage, some of which with the foregoing will be explained in the following description of those forms of the invention illustrated in the drawings. It is to be understood that the invention is not limited to the embodiments shown in the drawings as the inventive idea may be otherwise embodied within the definition of the claims.

In the drawings:

Fig. 1 is a broken vertical mid-sectional view of a firing head embodying the principles of the present invention, the parts being shown in detonating position.

Fig. 2 is a view similar to Fig. 1 illustrating the mechanism with the firing pin held in its normal cocked position, in readiness for release.

Fig. 3 is a transverse sectional view, the plane of the section being indicated by the line 3—3 of Fig. 2.

Figs. 4 and 5 are views partly in elevation, and partly in vertical mid-section, showing a modified form of the pin holding and releasing means, the firing pin being shown in its detonating position in Fig. 4 and in its cocked position in Fig. 5.

Fig. 6 is a transverse sectional view, the plane of the section being indicated by the line 6—6 of Fig. 5.

In terms of broad inclusion, the firing head of the present invention comprises a body connectable between a string of pipe and a perforating gun and provided with axially spaced firing and control chambers connected by an axial bore. A firing pin is slidably movable within the bore between a cocked position and a detonating position the ends of the firing pin being disposed within the firing and control chambers, and being normally held in cocked position by spring actuated means releasable by a go-devil to permit operation of the firing pins by hydrostatic pressure. Preferably the device comprises a pair of threadedly connected sections enclosing a firing charge and a firing pin assembled as a unit for connection between a string of pipe and a perforating gun.

In terms of greater detail, the firing head of the present invention comprises upper and lower body sections 1 and 2 threadedly joined by means of a threaded extension 3 formed on the lower end of the body section 1 engaging a correspondingly threaded recess in the upper end of body section 2. The upper end of the body section 1 is internally threaded, as at 4, for engagement with the lower end of a string of pipe designated in general by the numeral 5. The lower body section 2 is provided with a reduced extension 6 externally threaded as at 7 for engagement with a perforating gun, not shown, directly or through a suitable sub.

The engaging ends of the sections 1 and 2 are recessed to form a firing chamber within which is fitted a firing block 8 having bores 9 arranged to receive detonating shells 10. An axially disposed bore 11 formed in the lower section 2 communicates between the firing chamber and a threaded recess 12 formed in the extreme lower end of the section 2 to receive a coupling member 13. A booster cap 14, provided in the member 13, is operable to fire a primacord 15 attached to the lower end of the coupling member 13 in conventional manner. The upper end of the bore 11 flares to underlie the bores 9 in the firing block, each containing a detonating shell 10. The passage formed by the bore 11, is preferably filled with a powder train ignitable by the firing shells 10 for exploding the booster cap 14. Suitable sealing means 16, such as an O-ring, is engaged between the meeting ends of the sections 1 and 2. Similar sealing means 17 is engaged between the coupling member 13 and the lower end of the section 2. The O-rings 16 and 17 seal in the detonating shells, the powder train and the booster cap included therein, for igniting the primacord 15.

The body section 1 is provided with a control chamber 20 communicating with the string of pipe 5 threaded into the upper end of the body section. The control chamber communicates with the firing chamber through a passage 21, preferably axially disposed within the body section, and arranged to slidably engage a firing pin 22. The lower end of the firing pin 22 is provided with an enlarged head 23 movable within an enlarged portion 24 formed in the passage 21 immediately above its juncture with the chamber within which the firing head 8 is seated. A shoulder 26 limits upward movement of the head 23, which is movable downwardly from its uppermost position into firing engagement with the upper ends of the detonating shells 10.

Within the control chamber 20, suitable retaining means is provided for releasably securing the firing pin 22 in its raised or cocked position against the shoulder 26. In the preferred structure illustrated in Figs. 1, 2, and 3 of the drawings, this retaining means comprises a sleeve 27 slidably engaging the upper end of the firing pin. A control cap 28 is slidably mounted over the upper end of the sleeve 27, and is provided with a head plate 29 secured within the top of the cap 28 to extend over the top of the sleeve 27 and firing pin 22.

An annular groove 33 is formed upon the pin 22 near its upper end to releasably engage retaining balls 31, which are normally seated in receptacles 32 formed in the sleeve wall. The balls 31 are held in locking engagement with the groove 33 by the surrounding wall portion of the cap 28 when the cap is in its normal raised position. Upward movement of the cap 28 relative to the sleeve 27 is limited by a flange 34, inwardly disposed at the lower end of the cap, and engaging a shoulder 35 formed on the sleeve 27 in spaced relation to the groove 33. A compression spring 37 is mounted over the sleeve 27 between the cap 28 and a retaining flange 38 threaded or

otherwise secured to the lower end of the sleeve and seating upon the bottom of the control chamber **20**. In its uppermost position, as limited by the engagement of the flange **34** with the shoulder **35**, the control cap is held with the head plate immediately below the bottom of the string of pipe **5**, and in axial alignment therewith. The recess within the cap **28** and within which the upper end of the sleeve **27** is received, is enlarged at its upper end by an amount which slightly exceeds the depth of the annular groove **33**. When the cap is pressed downwardly over the upper end of the sleeve, the retaining balls **31** may move radially out of engagement with the groove, and thereby release the firing pin.

Ports **41** are formed in the wall of the lowermost section of pipe **5**, at a point above its engagement with the upper body section **1**. Also, ports **42** are formed in the side walls of the cap **28**. The ports **41** permit the flow of well fluid into the pipe **5**, and thence into the control chamber **20**. The ports **42** in turn permit flow of said fluid into the upper portion of the cap **28**, so as to equalize the hydrostatic pressure above and below the cap and its head plate **29**. Flow of such well fluid along the bearing area between the firing pin **22** and the inner surface of the passage **21** is prevented by appropriate sealing means, such as one or more O-rings **43**.

Preferably a bore **44** is formed diametrically through the firing pin **22** at a point such that it will be aligned with a corresponding bore **45** formed in the upper body section **1** when the pin is raised to its normal cocked position, as best indicated in Fig. 2 of the drawings. This permits a retaining pin (not shown) to be inserted through the registering bores to lock the pin against inadvertent displacement during shipment, storage or manipulation while the firing head is being connected between a perforating gun and a string of pipe. The retaining pin is of course removed before the head is lowered into the well.

Figs. 4, 5 and 6 illustrate a modified means for holding the firing pin **22** in its cocked position. In this arrangement a plurality of spring actuated retaining fingers **50** are mounted within the control chamber **20** for releasably engaging a head **51** formed upon the upper end of the firing pin **22**. The head **51** is received within locking recesses **52** formed on the inner edges of the fingers **50**, which are arranged to form a unit of annular form seating within the chamber **20**. The fingers are normally held in contracted relation in engagement with the head **51** by any suitable spring means. By way of illustration, an encircling spring **53** may be used as shown in Figs. 4, 5 and 6 of the drawings. The upper ends of the fingers **50** diverge to define a concave recess faced upwardly in alignment with the bottom of the pipe **5**, and are arranged to be spread apart by a go-devil **54** to release the head **51** from retaining engagement by the recesses **52**.

In operation, the firing head is assembled and loaded as a unit by initially moving the firing pin **22** to its normal cocked position where it is releasably held by the retaining means provided in the control chamber **20**. A locking pin may be inserted through the registering bores **44** and **45**, as a further guard, if desired. With the firing pin thus securely held in its cocked position, the firing block **8** with appropriate detonating shells **10** carried by the bores **9**, is seated for engagement between the upper and lower sections **1** and **2** where it is securely held when the sections are screwed together, as indicated in the drawings. A powder train is introduced into the bore **11** before or after the sections **1** and **2** are screwed together; and the coupling **13**, with the booster cap **14** in place therein, is then secured to the lower end of the assembly as indicated in the drawings.

The assembled sections **1** and **2** are connected as a unit between the string of pipe **5** and a perforating gun, not shown, in accordance with conventional practice, after which the assembly is lowered by the string of pipe **5** to the desired depth within a well. When the perforating gun has been positioned at the desired point in the well, a go-devil **54** is introduced into the string of pipe **5** from the top of the well. The go-devil moves downwardly through the string of pipe and strikes the retaining means with sufficient force to release the firing pin.

As illustrated in Fig. 1 of the drawings, the go-devil **54** drops onto the top of the head plate **29**, which is normally supported in spaced relation to the top of the firing pin **22** and sleeve **27**, as shown in Fig. 2 of the drawings. The head plate **29**, and the control cap as a whole, is subject to balanced hydrostatic pressure of the well fluid which enters the pipe **5** through the ports **41** and fills the chamber **20** and cap **28**. Force delivered by the go-devil moves the control cap **28** downwardly against the resistance of the spring **37** sufficiently to permit the retaining balls **31** to move outwardly into the enlarged upper portion of the chamber, and to disengage the annular groove **33** of the firing pin **22**. Fluid contained in and around the control cap **28** enters the sleeve **27** and forces the firing pin **22** downwardly with sufficient force to explode the detonating shells **10**. The shells **10** ignite the powder train contained in the bore **11**, which in turn explodes the booster cap **14** and ignites the primacord **15**. The projectiles or shaped charges carried by the perforating gun are then discharged by the primacord **15** in accordance with conventional practice, which of course varies with the particular type and construction of perforating gun employed.

The modification illustrated in Figs. 3 and 4 of the drawings operates in substantially the same manner, the spring fingers **50** being spread by the action of the go-devil to release the head of the firing pin which is then driven downwardly by hydrostatic pressure to explode the detonating shells **10** as above explained.

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

A firing head adapted to be connected between a string of pipe containing well fluid and a well perforating gun comprising: a body; a control chamber formed within an upper portion of said body in communication with a string of pipe, said upper portion having openings therein to admit the pressure of the well fluid; a firing chamber in a lower portion of said body arranged to receive a detonable charge; said body having a bore connecting said chambers; a firing pin slidably received in said bore for movement by the pressure of the well fluid between a cocked position and a detonating position; sealing means between said firing pin and said bore; an annular sleeve slidably engaging said pin within said control chamber and having an enlarged diametral end portion; a locking means for locking said pin to said enlarged portion of said sleeve including an annular groove on one end of said pin, lateral openings in the enlarged end portion of said sleeve and ball members disposed in said openings; a hollow control head slidably mounted on said sleeve for limited movement axially of said sleeve between a pin locking position and a pin releasing position, said control head having an upwardly facing surface exposed to the well fluid and arranged to be struck by a go-devil, said control head further having a recess portion sized to slidably engage said enlarged end portion of said sleeve in the pin locking position of said control head thereby urging said ball members inwardly into the annular groove of said firing pin and having an enlarged recess portion with openings therein to expose the end of said pin to the pressure of the well fluid and arranged to be disposed about said enlarged end portion of said sleeve in the pin releasing position thereby permitting said firing pin to be released; and spring means urging said head toward its locking position and permitting movement of said head to a pin releasing position in response to the weight of the go-devil.

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