Oct. 20, 1959 M. P. LEBOURG 2,909,120

BORE HOLE APPARATUS

Filed May 16, 1955 2 Sheets-Sheet 1

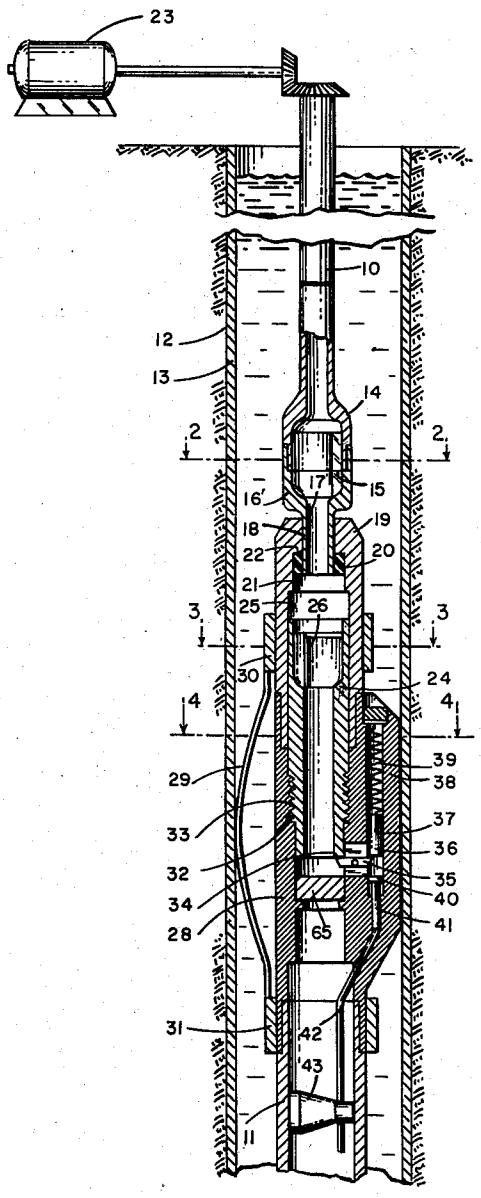


FIG. 1

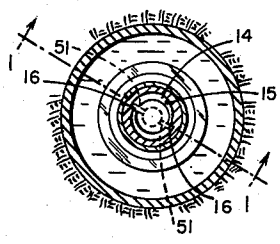


FIG. 2

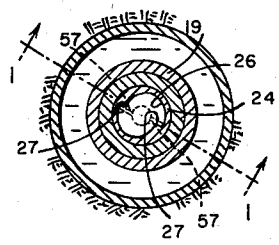


FIG. 3

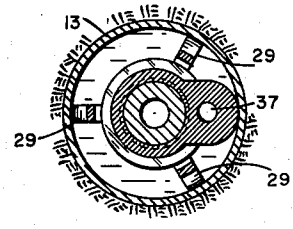


FIG. 4

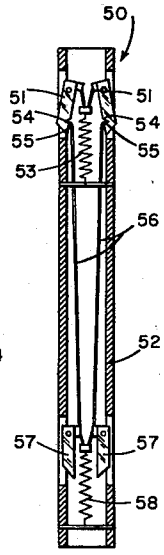


FIG. 5

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Oct. 20, 1959 M. P. LEBOURG 2,909,120

BORE HOLE APPARATUS

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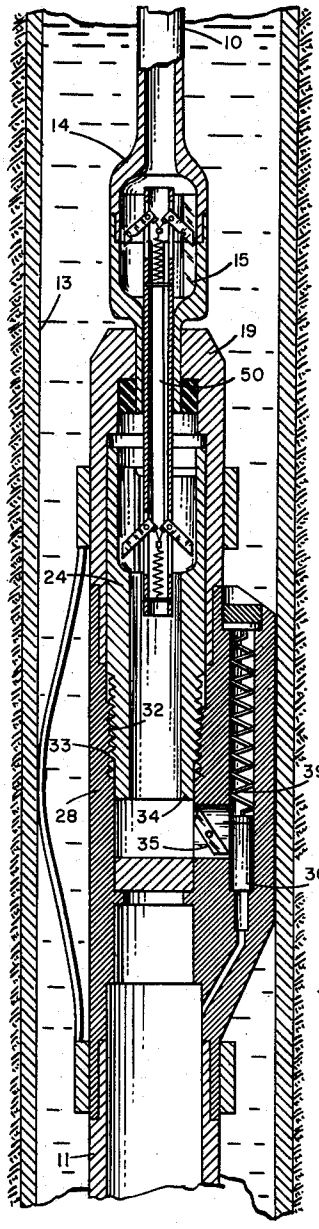


FIG. 6

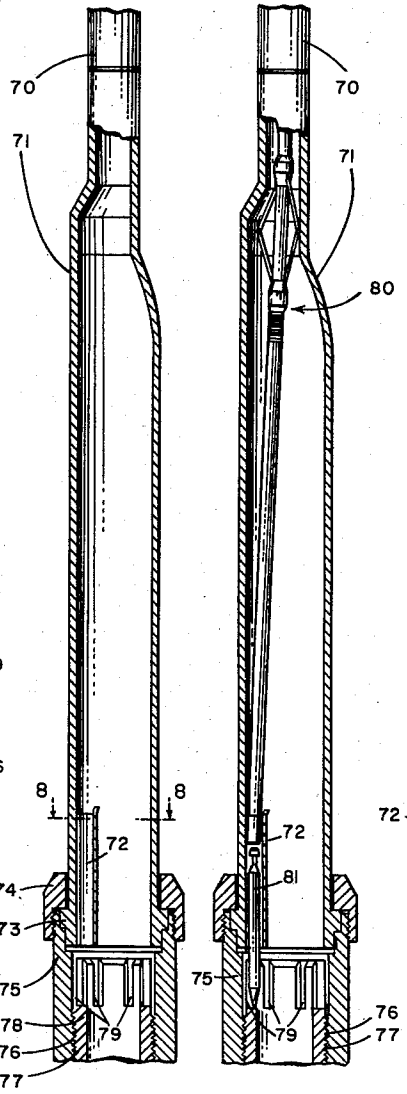


FIG.7

FIG.9

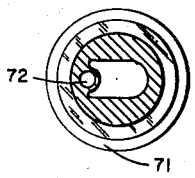


FIG.8

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BORE HOLE APPARATUS

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Application May 16, 1955, Serial No. 508,386
7 Claims. (Cl. 102—20)

This invention relates to bore hole apparatus and, more particularly, pertains to a new and improved actuating mechanism for an instrument adapted to be passed through a bore hole. Although useful in a variety of applications, an actuating mechanism featuring the present invention is ideally suited for use in a firing system of a well casing perforator. For convenience, it will be described in this connection.

In accordance with certain present techniques of well completion, a casing perforator is carried into the well at the lower end of a string of tubing and is actuated or fired after reaching a selected depth. To avoid the use of an electrical firing system including conductors extending to the surface of the earth, it has been proposed that the perforator be fired in response to movement of tubing. One form of this type of apparatus employed heretofore is arranged so that the perforator may be lowered with its firing mechanism in a disarmed condition. At the desired depth, the tubing is raised slightly thereby to arm the firing mechanism which then responds to rotation of the tubing to fire the perforator.

Obviously, the foregoing arrangement may not always provide a required degree of safety. This is understandable because in the event the tubing is raised prior to reaching the selected depth, the firing mechanism is armed and subsequent rotation of the tubing may set off the perforator at the wrong location in the well. In addition, since arming requires an upward displacement, it may not always be possible to position the perforator at a selected depth with sufficient accuracy. The latter deficiency may be avoided through the use of casing-engaging slips, but this undesirably complicates the mechanism.

It is, therefore, an object of the present invention to provide a new and improved actuating mechanism for a bore hole instrument which is not subject to the deficiencies of the just-described prior arrangement.

Another object of the present invention is to provide a new and improved actuating mechanism for a bore hole instrument, such as a well casing perforator, which features a higher degree of safety with respect to accidental operation than heretofore possible.

A further object of the present invention is to provide a new and improved actuating mechanism for a bore hole instrument in which the number of manipulations required of the tubing or drill pipe which supports the instrument to effect actuation is minimized.

Yet another object of the present invention is to provide a new and improved actuating mechanism for a bore hole instrument which is relatively simple to construct and yet is entirely efficient and reliable in operation.

Bore hole apparatus embodying the present invention comprises an instrument adapted to be carried through a bore hole by a support which includes a lower portion and an upper portion rotatable from the surface of the earth relative to the lower portion about a given axis. A member is mounted to the lower portion of the support for rotation relative thereto about the given axis and means are provided for selectively locking the upper portion of the support and the member for simultaneous rotation about the given axis. The apparatus further comprises means responsive to relative

rotation between the lower portion of the support and the member for actuating the instrument.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a view in longitudinal cross section of bore hole apparatus embodying the present invention shown in a disarmed condition of operation;

Figs. 2, 3 and 4 are cross sectional views taken along lines 2—2, 3—3 and 4—4, respectively, of the apparatus illustrated in Fig. 1;

Fig. 5 is a view in longitudinal cross section of a device which may be utilized for arming the bore hole apparatus shown in Fig. 1;

Fig. 6 is a view similar to the representation of Fig. 1, but drawn to an enlarged scale, and illustrating the apparatus in a condition of operation subsequent to arming and firing or actuation thereof;

Fig. 7 is a view in longitudinal cross section of a modification which may be made to a portion of the apparatus of Fig. 1, shown in a disarmed operating condition;

Fig. 8 is a view taken along line 8—8 of the modified arrangement shown in Fig. 7; and

Fig. 9 illustrates the apparatus of Fig. 7 in an armed condition of operation.

In Fig. 1 of the drawings, bore hole apparatus embodying the present invention is shown to comprise a tubing string **10** only the lower portion of which is represented, supporting an instrument such as a casing perforator **11** for movement through a bore hole **12** provided with a casing **13**. As will be apparent from the discussion to follow, an actuating mechanism constructed in accordance with the present invention is incorporated in the apparatus shown in Fig. 1 so that after perforator **11** is positioned at a selected depth, it may be fired by a simple manipulation of tubing **10**.

Tubing **10** is mechanically connected to an end bell **14** which, as best seen in Fig. 2, is provided with an interior cam-shaped portion **15**. With reference to a clockwise-rotating diametrical line in the plane of Fig. 2, the inner surface of cam **15** progressively decreases in diameter and abruptly increases in diameter to form diametrically opposed surfaces **16** disposed in a diametric plane.

End bell **14** is provided with a hollow, cylindrical extension **16'** having a section **17** of reduced diameter. Section **17** passes through an opening **18** in a coupling head **19** and is terminated by a flange **20** having a diameter larger than opening **18**. Coupling head **19** is provided with an enlarged interior portion **21** which receives flange **20** and defines a shoulder **22** against which the flange **20** seats. Appropriate bearings may be provided so that member **14—16** and coupling head **19** are freely rotatable relative to one another. It is thus seen that coupling head **19** may be defined as a lower portion of a support for instrument **11** and that tubing **10** and member **14—16** comprise an upper portion for the support which, for reasons to be more apparent from a discussion to follow, is rotatable relative to the lower portion about a longitudinal axis for the tubing by a driving motor **23** located at the surface of the earth and coupled to the upper end of the tubing.

A cylindrical control sleeve **24** is rotatably supported within a bore **25** extending within coupling head **19**. The upper end of control member **24** is provided with a cam-shaped interior surface **26** generally similar to surface **15** but having the opposite configuration. In other words,

as seen in Fig. 3, if a reference diameter is rotated in the same direction as the one used in connection with Fig. 2, surface 26 gradually increases in diameter and then abruptly decreases in diameter to define diametrically opposed surfaces 27 lying in a diametric plane. A depending, cylindrical extension 28 of coupling head 19 is mechanically connected to the upper end of perforator 11.

As was pointed out earlier, control member 24 is rotatable relative to coupling head 19 about the longitudinal axis of tubing 10 and to facilitate such relative movement, a plurality of bowed springs 29 are provided. As seen in Fig. 4, the springs 29 are equally spaced about this axis and are in biased engagement with casing 13. Their upper ends are mechanically connected to a collar 30 (Fig. 1) slidably supported on the exterior surface of coupling head 19 while their lower ends are connected to a collar 31 supported for sliding movement along extension 28 and the upper end of the housing for perforator 11. One or both of collars 30 and 31 is keyed to the member on which it is supported so that although the collars may be longitudinally displaced, they are not rotatable with respect to coupling head 19.

Members 24 and 28 are provided with corresponding threaded portions 32 and 33 so that, upon relative rotation between these members in a given direction about the axis of the tubing, member 24 is drawn upwardly. In the position illustrated, lower end 34 of member 24 is engaged by one end of a latch lever 35 pivotally supported by member 28. The remaining end of lever 35 is engaged by the lower extremity of a plunger 36 slidably disposed within a bore 37 extending longitudinally through a side extension 38 of member 28. A compression spring 39 within bore 37 biases plunger 36 in a downwardly direction.

Positioned at the lower end of bore 37 is a shear plate 40 covering a blasting cap 41. The blasting cap is associated with one end of a primacord 42 that is mechanically connected to one or more perforating units, such as shaped explosive charge 43. Although a single shaped charge has been illustrated, obviously additional charges or any other type of perforating units may be employed.

In the operating condition illustrated in Fig. 1, there is no mechanical connection for rotational movement between end bell 14—16 and control member 24. Consequently, the perforating apparatus may not be fired although the tubing 10 is raised, lowered or rotated in any direction.

To arm the apparatus, a go-devil 50 illustrated in Fig. 5 may be employed. The go-devil has an outer diameter slightly smaller than the inner diameter of tubing 10 and it is arranged to be dropped within the tubing. It includes a pair of locking fingers 51 supported opposite one another for pivotal movement out of individual openings in a housing 52. The fingers are retained by tubing 10 against the bias of a tension spring 53 and are provided with individual slots 54 which receive the upper, hooked ends 55 of a pair of retaining rods 56. The lower ends of rods 56 are attached to pivotally mounted locking fingers 57 and maintain them against the bias of a tension spring 58. Thus, the fingers 57 are restrained from moving through individual openings out of housing 52.

In order to arm the apparatus embodying the present invention, go-devil 50 is dropped into the upper end of tubing 10. When the go-devil passes through end bell 14—16 and the upper locking fingers 51 are pivoted by spring 53 toward cam surface 15, the hooked ends 55 are freed from recesses 54. Accordingly, spring 58 urges locking fingers 57 toward the cam surface 26. A slight rotation of tubing 10 may then bring the cam surfaces to positions in which the locking fingers engage the flat surface portions 16 and 27 of the cam surfaces 15 and 26 as shown in dash outline in Figs. 2 and 3. Thus, as seen in Fig. 6, means are provided for selectively locking end bell 14—16 and control member 24 for simultaneous rotation in a clockwise direction about the axis of tubing 10 (with reference to the representations of Figs. 2 and 3).

Driving motor 23 may then be energized and it rotates tubing 10 in a clockwise direction. Since go-devil 50 mechanically locks tubing 10 and control member 24 together for simultaneous rotation, and since bowed springs 29 engage the inner surface of casing 13, members 24 and 28 are rotated relative to one another. By reason of the action of threaded portions 32 and 33, member 24 is drawn upwardly relative to member 28 and end 34 is drawn away from engagement with pivoted latch 35. Consequently, spring 39 is permitted to displace plunger 36 downwardly and it ruptures shear plate 40 (Fig. 1). Plunger 36 fires blasting cap 41 which ignites primacord 42, and the explosive charge 43 is detonated. It is thus evident that the bore hole apparatus embodying the present invention includes means responsive to relative rotation between members 24 and 28 for actuating instrument 11.

If desired, an expendable plug 65 shown in Fig. 1 may be provided to close the internal bore of member 28. Consequently, prior to the detonation of shaped charges 43, tubing 10 is closed off from the perforating gun. However, the blast from charge 43 breaks the expendable plug 65 thereby providing a full opening at the lower end of member 28 so that in a permanent well completion process, fluid may flow through extension 28, control member 24, head 19, end bell 14—16 and through tubing 10 to the surface of the earth.

From the foregoing discussion, it is apparent that an actuating mechanism constructed in accordance with the present invention permits an instrument, such as a casing perforator, to be lowered on the end of a string of tubing in a safe, disarmed condition. The tubing may be displaced longitudinally or rotated in any direction, but the instrument may not be actuated. Consequently, a higher degree of safety is provided than heretofore possible.

Once the go-devil is inserted, however, the actuating mechanism is effectively armed so that simply by rotation of tubing 10 the perforating instrument may be detonated. Thus, the perforating instrument may remain at an accurately determined depth at the time it is actuated.

Actuation, of course, may be effected with certainty whenever desired. Accordingly, although the apparatus embodying the present invention is relatively simple and inexpensive to construct, it operates efficiently and reliably.

In Fig. 7 there is shown a modification which may be made to the upper portion of the apparatus of Fig. 1. Extending from tubing 70 is a hollow, offset section 71 having a go-devil receiving pocket 72 secured to one side of the lower extremity. As best seen in Fig. 8, pocket 72 is generally cylindrical. A flange 73 at the lower exterior of section 71 provides a seat for a collar 74 which is attached to a sleeve 75. The collar 74 and sleeve 75 are rotatable relative to member 71 and a suitable bearing may be provided for this purpose.

The inner surface of member 75 has threads 76 cooperating with external threads 77 of a control member 78. The upper end of control member 78 is provided with a plurality of slots 79 for receiving a go-devil, as will be explained in the discussion to follow. Members 75 and 78 correspond to members 28 and 24, respectively, in the arrangement of Fig. 1. It is evident that the modified bore hole apparatus may be introduced into a well in a disarmed condition.

As shown in Fig. 9, at a selected depth, a pocket-type setting tool 80 carrying a go-devil 81 is inserted into tubing 70. Thus, the go-devil may be set within pocket 72 so that it passes through the lower end of pocket 72 and is received by one of the slots 79. Accordingly, member 71 is effectively locked to member 78 for rotation about a longitudinal axis of the tool. The tubing 70 may then be rotated and through the action of threads 76 and 77

the control member 78 is drawn upwardly relative to member 75 to achieve the firing action explained in connection with Fig. 6.

It is thus seen that in the embodiment of the invention illustrated in Figs. 7–9, a safety sleeve (control member 78) is entirely free from the drill pipe or tubing until a key or go-devil 81 is set to lock the two components together. This is likewise featured in the embodiment described hereinbefore in connection with Figs. 1–6.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects, and therefore the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. Bore hole apparatus comprising: an instrument adapted to be actuated in a bore hole; a support for carrying said instrument into the bore hole and including a lower portion and an upper portion rotatable from the surface of the earth relative to said lower portion about an axis; a member mounted to said lower portion of said support for rotation relative thereto about said axis; go-devil receiving means associated with said upper portion of said support; go-devil receiving means associated with said member; a go-devil having means cooperating with said go-devil receiving means to lock said upper portion of said support and said member to one another for simultaneous rotation about said axis; and means responsive to relative rotation between said lower portion of said support and said member for actuating said instrument.

2. Bore hole apparatus for use in a bore hole having a casing comprising: an instrument adapted to be actuated in the bore hole; a support for carrying said instrument into the bore hole and including a lower portion and an upper portion rotatable from the surface of the earth relative to said lower portion about an axis; spring means connected to said lower portion of said support and adapted to engage the casing to restrain said lower portion of said support against rotation about said axis; a member mounted to said lower portion of said support for rotation relative thereto about said axis; means for selectively locking said upper portion of said support and said member for simultaneous rotation about said axis including locking surfaces disposed, at least in part, in non-concentric relation to said axis and a locking device adapted to be passed along said support and having means cooperating with the said locking surfaces; and means responsive to relative rotation between said lower portion of said support and said member for actuating said instrument.

3. An actuating mechanism for a bore hole instrument comprising: a support adapted to be passed through a bore hole and including a first portion and a second portion rotatable from the surface of the earth relative to said first portion about a longitudinal axis for said support; a member carried by said first portion of said support and rotatable relative thereto about said longitudinal axis; means integral with each of said second portion of said support and said member defining individual locking surfaces disposed in non-concentric relation to said axis; a locking device adapted to be passed along said support and having means cooperating with said locking surfaces for selectively locking said second portion of said support and said member for simultaneous rotation about said longitudinal axis; and means responsive to relative rotation between said first portion of said support and said member for actuating a bore hole instrument carried by said support.

4. Bore hole apparatus comprising: an instrument adapted to be actuated in a bore hole; a support, having a longitudinal axis, for carrying said instrument into the bore hole and including a lower portion and a hollow upper portion rotatable from the surface of the earth relative to said lower portion about said axis and having at least one surface displaced from said axis and disposed in a plane intersecting said axis; a hollow member mounted to said lower portion of said support for rotation relative thereto about said axis and having at least one surface displaced from said axis and disposed in a plane intersecting said axis; a go-devil, selectively positionable within said hollow upper portion of said support and said hollow member and including locking fingers for engaging said surfaces thereby to lock said upper portion of said support and said member for simultaneous rotation about said axis; and means responsive to relative rotation between said lower portion of said support and said member for actuating said instrument.

5. An actuating mechanism for a bore hole instrument comprising: a tubular support having a longitudinal axis adapted to be passed through a bore hole and including a lower portion and including an upper portion rotatable from the surface of the earth relative to said lower portion about said axis and having at least one surface displaced from said axis; a hollow member received by said lower portion of said support and rotatable relative thereto about said axis and having at least one surface displaced from said axis; a go-devil adapted to be lowered through said tubular support to a position within said upper portion of said support and within said member and including retractable locking fingers for engaging said surface thereby to lock said upper portion of said support and said member for simultaneous rotation about said axis; and means responsive to relative rotation between said lower portion of said support and said member for actuating a bore hole instrument carried by said support.

6. Bore hole apparatus comprising: an instrument adapted to be actuated in a bore hole; a support for carrying said instrument into the bore hole and including a lower portion and an upper portion rotatable from the surface of the earth relative to said lower portion about an axis and having an opening displaced from said axis; a member mounted to said lower portion of said support for rotation relative thereto about said axis and having an opening adapted to be aligned with said opening in said upper portion of said support; a go-devil adapted to be selectively positioned within said openings in said upper portion of said support and said member; means operatively associated with said go-devil for locking said upper portion of said support and said member for simultaneous rotation about said axis; and means responsive to relative rotation between said lower portion of said support and said member for actuating said instrument.

7. An actuating mechanism for a bore hole instrument comprising: a tubular support adapted to be passed through a bore hole and including a lower portion and an upper portion rotatable from the surface of the earth relative to said lower portion about a longitudinal axis for said support and having a go-devil receiving pocket displaced from said axis and having an opening in its lower end; a hollow member received by said lower portion of said support and rotatable relative thereto about said longitudinal axis and having a plurality of slots at its upper end, each alignable with said opening in said pocket; a go-devil adapted to be lowered through said tubular support to a position within said pocket, extending through said opening and into one of said slots for locking said upper portion of said support and said member for simultaneous rotation about said longitudinal axis; and means responsive to relative rotation between said lower portion of said support and said member for actuating a bore hole instrument carried by said support.

References Cited in the file of this patent

UNITED STATES PATENTS

2,186,323	Brown	Jan. 9, 1940
2,621,732	Ahlgren	Dec. 16, 1952
2,696,759	Connolly	Dec. 14, 1954