June 9, 1953 J. R. LOCKETT 2,641,185

DELAYED-ACTION DETONATOR FOR FIRING EXPLOSIVES

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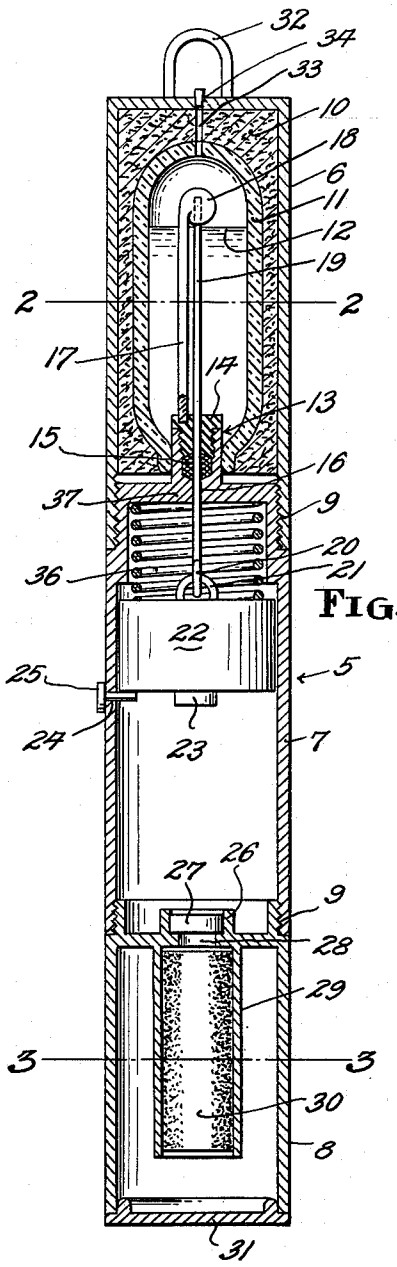

FIG. 1.

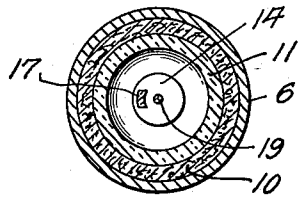

FIG. 2.

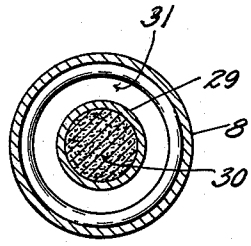

FIG. 3.

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DELAYED-ACTION DETONATOR FOR FIRING EXPLOSIVES

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8 Claims. (Cl. 102—20)

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The present invention relates to an improved delayed-action detonator for firing explosives. More particularly, the present invention has application to detonators of this type which are adapted to be lowered into a well bore to effect controlled detonation of a body of explosives previously laid in the bottom of the bore.

In the past, various types of time-controlled detonators have been proposed and actually used in setting-off the main explosive charge contained in the bottom of a subterranean well, but generally, such previous detonators utilized relatively expensive and highly precisioned clock mechanisms as the time-controlling element of such detonators. In operation, such clock mechanisms were completely destroyed upon explosion, thereby making the overall operation costly and wasteful. Further, such clock mechanisms were generally subject to mechanical failure due to their relatively complex and highly precisioned construction which required extreme care in handling. It will be manifest, that operational failure or premature operation in such time-controlling apparatus, when used to set-off a detonating charge, would result in extremely dangerous conditions and hazardous operations.

A primary object of the present invention, therefore, is to provide a relatively inexpensive, yet efficient, time-controlled detonator, which entirely eliminates the use of relatively expensive and delicate clock mechanisms, and which is characterized by its rugged construction and one capable of withstanding relatively severe handling and shock without likelihood of damaging the time-delay mechanism of the detonator, and thereby reducing the possibility of premature explosions or faulty operation on the part of the detonator.

Another object of this invention is to provide an improved detonator which lends itself, particularly, for use in tamping operations, wherein a portion of a well bore is filled prior to blasting to prevent damage to the bore upon explosion and enlargement of the well hole, it being understood that a substantial time delay is required for the lowering of the detonator and filling of the well bore before detonating the main explosive charge.

It is another object of the present invention to provide a detonator whose explosive action is controlled in response to the time required for completion of a chemical reaction, rather than in response to the operation of a clock mechanism or other moving parts.

It is still a further object of this invention to

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provide an improved detonator for underground wells which embodies a time-controlling system consisting of a chemical compound, preferably one of the solvent type, and a link formed from a material subject to chemical attack or disintegration upon contact or reaction with said compound, whereby upon predetermined disintegration on the part of the link causes a mechanical action which results in the setting off of an associated explosive charge, the time of reaction between the chemical compound and the link controlling the time of explosion of the detonator.

This application is a continuation-in-part of my prior co-pending application, Serial No. 21,425, filed April 16, 1948, and allowed October 10, 1950.

For a further and more detailed understanding of this invention and the various additional objects and advantages realized thereby, reference is made to the following description and the accompanying drawing, wherein:

Fig. 1 is a medial transverse vertical sectional view taken through a detonator formed in accordance with the present invention;

Fig. 2 is a horizontal sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a similar view taken along the line 3—3 of Fig. 1.

Referring to the drawing, the numeral 5 generally designates an outer cylindrical casing comprising three detachably united sections, namely: an upper end section 6, a center section 7, and a lower end section 8. The separate sections of the casing are formed with cooperative screw-threaded unions 9 by which detachable connection may be had for purposes of assembly.

Carried within the upper end section of the casing, and thermally insulated therefrom by means of a layer of insulating material 10, such as asbestos fiber, is an open mouth vial or bottle 11 whose mouth opens substantially at the lowermost end of the upper end section toward the center section 7 of the casing. The vial 11 may be formed from any suitable corrosive-resistant material, or other material resistant to chemical attack, such as glass, porcelain, or one of the corrosive-resistant synthetic resins, and as such, serves as a container for a body of chemical 12, such as, one of the corrosive acids, for example sulphuric acid, hydrochloric acid, nitric acid, aqua regia, etc., or for any suitable organic solvent, such as acetone and the like, the purposes of which are to be hereinafter more fully outlined.

The intermediate or center section 7 of the casing is provided at its upper end with an axially disposed plug or stopper device 13 which, upon connection of the upper end section and center section, is inserted within the open mouth of the vial 11 to close the same. The stopper 13 is formed at its outer end with a detachable plug member 14 which is provided with an annular packing gland 15 defining the intermediate portion of an axially disposed opening 16 which extends completely through the stopper member and the upper wall of the intermediate casing. Further, the plug member 14 carries a longitudinally extended projection or supporting member 17 which is preferably formed from a corrosion-resistant material, or other material resistant to chemical attack, such as glass etc., and which, upon connection of the upper end and center sections of the casing, extends well into the vial 11, and terminates in an enlarged head 18.

Extending through the axially disposed opening formed in the stopper member 13, and connected at its upper end with the enlarged head 18 of the supporting member 17, is a corrosive or solvent-fusible link 19 which, when the chemical 12 constitutes an acid solution, such as sulphuric acid, aqua regia or the like, is preferably formed from a metal or metal alloy which responds readily when chemically attacked by the acid, and which will disintegrate in a relatively short period of time in the acid. It will be understood, that the concentration of the corrosive chemical or solvent plus the size of the link 19 will determine more or less the time required for disintegration or parting of the link, and these two factors may be varied to meet the desired time requirements with reference to the operation of the detonator. It will further be understood, that the material from which the link 19 is formed may constitute a metal, such as copper, magnesium, aluminum or other metals or alloys thereof capable of chemical reaction and disintegration under solvent action or by a corrosive acid, such as those outlined above, or the link may be formed from a suitable synthetic resin, such as one of the cellulose derivatives, whereupon the corrosive chemical would be replaced by a suitable solvent for such a resin such as acetone and the like.

The upper end of the link 19 may be secured in any suitable manner to the enlarged portion 18 of the supporting member 17, in order that a rigid connection may be obtained, such as by fusing the two materials together, cementing, or mechanically uniting the same. The lower end of the link 19 extends interiorly of the center section 7, and is hooked, as at 20, for connection with a bail member 21 carried at the upper end of a weighted striking piece 22. The striking piece 22 is freely suspended at the lower end of the link 19 within the center section 7 of the casing, and is free to drop therein in response to gravity upon parting or disintegration of the link. The lower portion of the striking piece 22 is formed with an axially disposed projection 23 which provides a cap-contacting pin or surface for the striking piece. For purposes of safety in handling, the outer wall of the center section 7 is provided with an opening 24 through which a holding pin 25 may be inserted for holding engagement with the lower surface of the weighted striking piece 22. It will be understood, that the pin 25 is inserted for the purpose of holding the striking piece in the event that the link 19 should inadvertently break during handling, or should prematurely fuse prior to lowering within a well bore. The pin is removed at the time the detonator is ready for operation and for lowering within the bore of the well.

The lower end section 8 of the casing is formed at its upper end with an axially disposed cap-receiving socket 26 in which is positioned a percussion type detonating cap 27 which, upon connection of the center and lower end sections, is disposed in spaced longitudinal alignment with the striking projection 23 of the weighted striking piece 22. The lower wall of the socket 26 is formed with an opening 28 providing communication between the socket and a relatively enlarged tubular housing 29 for the reception of a dynamite stick or other suitable explosive charge 30. At its lowermost end, the lower end section of the casing is provided with a frictionally held cover plate 31 which, upon explosion of the explosive charge 30, is projected forcibly from the remainder of the casing to release the explosive blast thereby detonating a main charge within the well bore or hole. Thus, a main explosive charge previously deposited in the bottom of the well may be detonated by the blast of the detonator directed through the bottom of the casing.

For purposes of attaching the detonator to a lowering cable or line, the upper end section 6 of the casing is provided with a U-shaped bail 32 whereby facile and quick attachment may be had with any suitable hook member carried at the end of an associated lowering line or cable.

In the event that the particular chemical compound or solvent used produces a gas or relatively extreme heat upon reaction with the link, the upper portion of the vial 11 may be provided with a vent opening 33 which extends exteriorly of the casing, as at 34, in order that consequent pressures may be released from the interior of the vial. It will be understood, that such vent opening would normally be closed during filling operations and until the vial occupies its normal inverted position of operation.

In operation, the desired time delay of operation of the detonator is determined primarily by the composition and size of the destroyable link member 19, and secondarily by the concentration or composition of the corrosive chemical, solvent or other chemical compound. For instance, when utilizing sulphuric acid as a corrosive medium, with the relative concentration thereof determined, the diameter or gage of the link 19 may be varied to adjust the time at which the same will be disintegrated by chemical reaction with the acid. For example, a relatively thin wire obviously will disintegrate more rapidly than will a relatively thicker one, thereby varying the time delay before explosion. The ratio between the concentration of corrosive material, and the thickness of the wire or fusible link may be easily computed prior to assembly of the separate sections of the detonator, whereby a known time interval required for disintegration or parting of the link may be obtained through predetermined calculations or observations. It has been found through practice, that the times of reaction with a given concentration of acid, and a given thickness of link is substantially uniform and constant and subject to very little variance, thereby making possible relatively exact time delay calculations.

Upon assembly, the upper section 6 of the casing is arranged so that the mouth of the vial 11

is turned upwardly, at which time the corrosive or solvent is introduced therein, and the center or intermediate section 7 of the casing is then threaded within the inverted upper section to stopper the vial and introduce the upper portion of the link therein. Next, the lowermost section 8 which carries the percussion cap and explosive charge, is threaded into the lower end of the center section, and the safety pin 25 inserted until the detonator is ready for actual use. It will be understood, that the chemical reaction between the link and the corrosive chemical compound will begin upon insertion of the link therein, and hence the time interval starts upon assembly of the various casing sections. Hence, assembly is effected immediately prior to lowering within the well bore, in order to avoid any possibility of premature parting or disintegration of the fusible link. After detachment of the pin 25, the detonator is then lowered within the well bore, for ultimate disposition at the bottom of the well in close relation to the main explosive charge previously deposited therein. Upon disintegration of the link 19 with the casing occupying a substantially vertical position, the weighted striking piece 22 will fall into striking engagement with the percussion cap 27 thereby setting off the explosive charge 30, and ultimately the main explosive charge deposited in the bottom of the well.

It is preferable to provide a coil spring or its equivalent, as shown at 36. Said spring is preferably arranged between the wall 37 of the section 7 and the weight or inertia member 22 forming the striking piece. The spring thus enables the striking piece 22 to function when released even through the detonator as a whole may not be in a truly vertical or pendant position, as illustrated in Fig. 1. Thus the striking piece need not rely on gravity alone to bring the same into contact with the cap 27, as the expansion of the spring will produce the desired travel of the released striking piece, hammer or inertia member. It has been found that sometimes in the lowering of the detonator into the bottom of a well bore, the same upon contacting the body of the explosive charge to be fired, will be tilted or rocked from a true vertical position, hence the importance of the spring.

In view of the foregoing, it will be seen that the present invention provides a structurally simple yet mechanically efficient time-controlled detonator for subterranean well operations which is characterized by its freedom from relatively complex and delicate mechanisms or instruments which ordinarily increase the hazards and cost of previously known detonators. Through the simple medium of chemical reaction, the time of operation of the detonator is controlled critically and uniformly.

Preferably, the vial or acid-container is thermally insulated from the remainder of the casing, in order that a constant temperature may be maintained within the corrosive chemical or solvent to prevent increases or decreases in the calculated time interval of operation due to temperature variations. The vial or acid container may also comprise a vacuum-type bottle which further serves to prevent temperature variations within the acid or solvent.

While a preferred embodiment of this invention has been disclosed in detail, it will be manifest that various modifications relating to constructional details may be accomplished without

departing from the spirit of the invention or the scope of the following claims.

I claim:

1. A detonator for wells comprising an elongated outer casing formed from a plurality of detachably connected longitudinally adjoining hollow sections; a chemical-receiving vessel carried within one of the sections of said casing and having an open mouth opening toward one end of said section; a stopper device carried at one end of another of the sections of said casing for closing the open mouth of said vessel upon connection of said first two-named sections; a fusible link extending through said stopper device for insertion within said vessel upon attachment of said first two-named sections, said link being formed from a material subject to chemical attack by a chemical contained in said vessel; a weighted striking piece slidably carried within said stopper-carrying section and supported at one end of said fusible link, said striking piece being arranged within said last-named section to fall from one end to the other thereof by gravity upon disintegration of said link and when said first two-named sections are positioned in a substantially vertical plane with said last-named section positioned below the vessel-carrying section; a percussion cap carried in an end of another of the sections of said casing for longitudinal alignment with said striking piece upon attachment of its casing section with the section carrying said striking piece; an explosive charge carried within the cap-carrying section of said casing adjacent to said percussion cap; and means carried on said first-named casing section for attaching said casing in a depending position to an end of a lowering line.

2. A detonator for wells comprising an outer casing having a plurality of readily detachable longitudinally adjoining hollow sections; a bail carried by one of the sections of said casing for attaching said casing in a vertically depending position at an end of a lowering line; an open-mouth vessel positioned within one of the sections of said casing and occupying an inverted position upon attachment of said casing to a lowering line; a stopper device carried at one end of a second casing section for closing the mouth of said vessel upon attachment of said second casing section with said first-named section; a fusible link extending through an end of said second section and said stopper device and having an end portion insertable within said vessel upon attachment of said first-named sections, said link being formed from a material subject to disintegration upon chemical attack by a corrosive chemical positioned within said vessel; a weighted striking piece carried within said second casing section and supported by the opposite end of said link, said striking piece being arranged within said second section to drop by gravity from one end to the other thereof upon disintegration of said link and with said casing sections arranged in a vertical plane; a percussion cap carried in an end of a third casing section for vertical alignment with said striking piece upon attachment of said third section with said second section; and an explosive charge carried within said third section adjacent to said percussion cap.

3. A detonator for wells comprising an outer casing having a plurality of readily detachable longitudinally adjoining hollow sections; a bail carried by one of the sections of said casing for attaching said casing in a vertically depending

position at an end of a lowering line; an open-mouth vessel positioned within one of the sections of said casing and occupying an inverted position upon attachment of said casing to a lowering line; a stopper device carried at one end of a second casing section for closing the mouth of said vessel upon attachment of said second casing section with said first-named section; a fusible link extending through an end of said second section and said stopper device and having an end portion insertable within said vessel upon attachment of said first-named sections, said link being formed from a material subject to disintegration upon said chemical attack by a corrosive chemical positioned within said vessel; a weighted striking piece carried within said second casing section and supported by the opposite end of said link, said striking piece being arranged within said second section to drop by gravity from one end to the other thereof upon distintegration of said link and with said casing sections aranged in a vertical plane; a percussion cap carried in an end of a third casing section for vertical alignment with said striking piece upon attachment of said third section with said second section; and explosive charge carried within said third section adjacent to said percussion cap; and a removable pin extending through said second casing section below said striking piece for holding said striking piece against movement within said casing independently of said link.

4. A detonator for wells comprising an outer casing for attachment to a lowering line and having detachably connected upper, lower and intermediate sections; an open-mouth vial carried in the upper section of said casing for the reception of a corrosive chemical; a plug device carried by the intermediate section of said casing for closing the mouth of said vial; a link extending through said plug device and having one of its ends extending into said vial and its opposite end extending within said intermediate section, said link being formed from a material subject to distinegration upon prolonged contact with a corrosive chemical contained in said vial; a weighted striking device suspended within the intermediate section of said casing at the opposite end of said link; a percussion cap carried within the lower section of said casing in longitudinal alignment with said striking device; and an explosive charge carried within the lower section of said casing adjacent said percussion cap.

5. A detonator for wells comprising a casing for lowering within an oil well bore, said casing comprising upper, lower and intermediate detachably connected sections; a corrosive chemical-containing vial carried within the upper section of said casing and opening toward the intermediate section thereof; a closure for said vial carried by the intermediate section of said casing and formed with a longitudinally extended support extending within said vial and an axially disposed opening; a link extending through the opening of said closure and attached at one of its ends to the extended support thereof and having its opposite end disposed within the intermediate section of said casing, said link being formed from a material subject to chemical disintegration under action of a corrosive chemical contained in said vial; a weighted striking device suspended within the intermediate section of said casing at the opposite end of said link; a percussion cap carried within the lower section of said casing in spaced longitudinal alignment with said striking device; and an explosive charge carried within the lower section of said casing adjacent said percussion cap.

6. A detonator for underground wells comprising an elongated cylindrical casing for lowering within a well bore and including a plurality of detachably connected longitudinally adjoining sections; an acid-containing vial carried within one section of said casing and opening toward another section thereof; a closure for said vial carried by the last-named section of said casing and formed with a longitudinally disposed support projecting within the vial and an axially disposed opening extending through said closure; an acid-fusible link slidably carried within the opening of said closure and attached at one of its ends to the support thereof; a striking device suspended within the last-named section of said casing at the opposite end of said link; a percussion cap carried within a third section of said casing in spaced longitudinal alignment with said striking device; and an explosive charge carried adjacent said percussion cap.

7. A detonator comprising an elongated outer casing formed from a plurality of detachably connected longitudinally adjoining hollow sections; a chemical-receiving vessel carried within one of the sections of said casing, said vessel having an open mouth opening toward one end of the section in which the vessel is arranged; a stopper device carried at one end of another of the sections of said casing for closing the open mouth of said vessel upon connection of said first two-named sections; a destroyable link extending through said stopper device for insertion within said vessel upon attachment of said first two-named sections, said link being formed from a material subject to interaction with a chemical contained in said vessel with resulting disintegration of the link; a weighted striking piece slidably carried within said stopper-carrying section and supported at one end of said link, said striking piece being arranged within said last-named section to move from one end to the other thereof upon disintegration of said link and when said first two-named sections are positioned in joined relationship, a percussion cap carried in an end of another of said sections of said casing for longitudinal alignment with said striking piece upon attachment of a casing section with the section carrying said striking piece; an explosive charge arranged within the cap-carrying section of said casing adjacent to said percussion cap; and means carried on said first-named casing section for attaching said casing in a depending position to an end of a lowering line.

8. A detonator for fluid-producing subterranean wells, comprising an outer casing having a plurality of detachable longitudinally adjoining sections, means carried by the upper of said sections for attaching said casing in a vertically depending position at the end of a lowering line; an open-mouthed vessel positioned in one of the sections of said casing and occupying an inverted position upon attachment of said casing to a lowering line; a stopper device carried in one end of a second casing section for closing the mouth of said vessel upon attachment of the second section with said first-named section, a destroyable link extending through an end of said second section and said stopper device, said link having an end portion insertable within said vessel upon attachment of said first-named section said link being formed from a material subject to disinte-

gration upon chemical attack by a disintegration-producing chemical positioned within said vessel; a movable striking piece carried within said second casing section and supported by the opposite end of said link, a spring in said second section, said striking piece being arranged within said second section to move by gravity and under the influence of said spring from one end of the second section to the other following disintegration of said link; a percussion cap carried in an end of a third section, said cap being disposed in alignment with said striking piece when the latter is released and following attachment of said

third section with said second section, and an explosive charge carried within said third section adjacent to said percussion cap.

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