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INITIATION DEVICE DESENSITIZED BY FLUIDS

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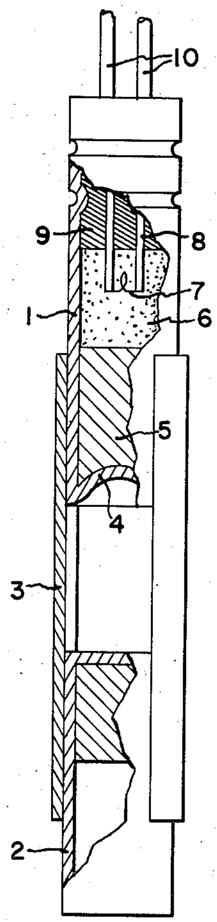

Fig. 1

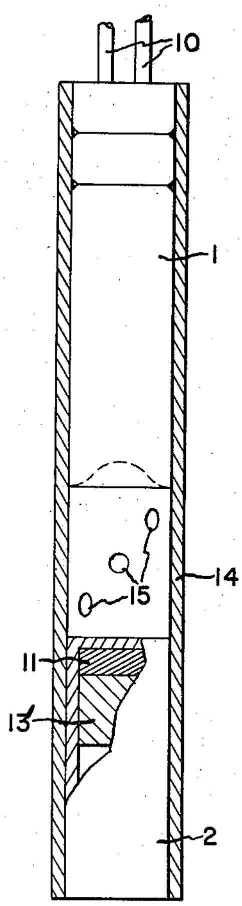

Fig. 2

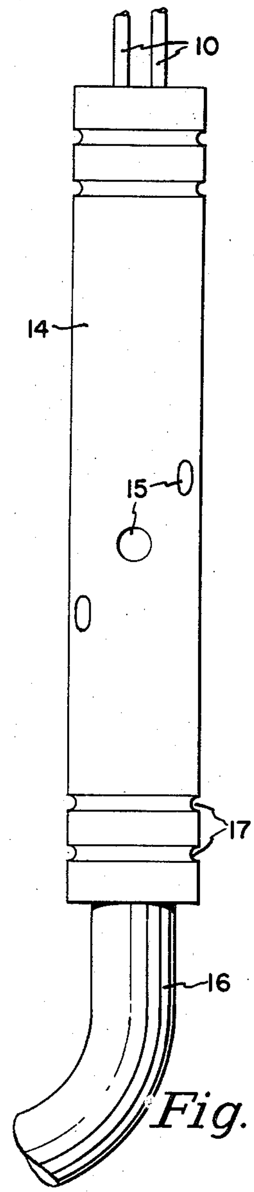

Fig. 3

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INITIATION DEVICE DESENSITIZED BY FLUIDS

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The present invention relates to a novel initiation device. More particularly, this invention relates to an initiation device especially suitable for use in an oil-well perforating assembly.

A means widely used for perforating oil well casings involves the use of lined shaped charges of a high velocity detonating explosive. Generally, a plurality of perforations in a selected area is desired, and the practice followed is to position several perforators as a group and initiate them at one time. For effective penetration, the lined cavity of the perforator must be free of any substantially incompressible material. Because the casings to be perforated are frequently filled with water or oil or mixtures of water and oil, means to prevent the cavity from becoming filled with the liquid must be provided. The production of self-sufficient individual units is feasible, and is presently being done; however, the cost of the units is necessarily high. An alternative expedient in widespread use is to position the plurality of perforating units in a liquid-tight carrier having destructible parts through which the penetrating jet is directed. To withstand the tremendous pressures encountered within the wells, the carrier must be sturdily built, and is, therefore, relatively expensive. However, inasmuch as the carrier can be reused many times if undamaged by the detonation of the perforating units, this arrangement is much favored.

Despite intensive precautions to make the carriers leakproof, an occasional leaker is encountered. When this occurs, the carrier is invariably deformed by the pressures produced by the detonation of the perforators because the relatively incompressible liquid does not permit the rapid expansion of the products of detonation throughout the interior of the carrier, the casing is improperly perforated, if at all, because the jet could not form, and, worst of all, the assembly may be jammed in the casing so that the assembly cannot be raised to the surface by the attached lowering cable and must be removed by one or more costly operations. Such operations do not otherwise improve the well and are most undesirable. Altogether, the consequences of a leaker can be so serious that additional safeguards are sought by the industry. This invention relates to such safeguard by providing a device which will not permit initiation of the perforators in the event liquid of any kind enters the carrier.

Accordingly, an object of this invention is to provide an initiation device which is inactivated by the presence of a liquid. A further object is to provide an initiation device which is inactivated by the presence of a liquid

but is unaffected by ordinary climatic conditions. Additional objectives will become apparent as my invention is more completely described.

I have found that the foregoing objects may be attained when I position a receptor having a metal shell with one integrally closed end and an impact-sensitive explosive charge partially filling said closed end in axial alignment to an electric detonator haivng a metal shell with an integrally closed end so that the respective integrally closed ends face each other but are spaced apart a distance such that when the space between them is unobstructed, detonation of the detonator will produce initiation of the receptor, whereas, on the other hand, when the space is obstructed, as by a liquid, detonation of the detonator will not produce initiation of the receptor. The detonator and receptor may be maintained in the described relationship by any means which will not prevent the entrance of liquid into the space between the ends and which is itself not an obstruction. Initiation of the receptor will produce initiation of the detonating fuse to which the receptor is attached.

The initiation device constructed in accordance with the present invention will preferably be located in the bottom of the carrier of the perforators, so that even the partial filling of the carrier will inactivate the device and thereby prevent initiation of the perforator units. Thus, when the carrier is raised, the failure can instantly be detected and, after the repairs or corrections have been made to prevent further leakage, the initiation device can be replaced and the unit reused directly.

In order to more fully describe the present invention, reference is made to the accompanying drawings in which two specific embodiments are illustrated. The invention can be incorporated in many designs and variations, and these drawings are illustrative only.

In the drawings, Figure 1 represents the device of the present invention wherein the detonator and receptor are retained in the desired relationship by a pair of strips; Figure 2 represents a preferred embodiment wherein the detonator and receptor are surrounded by a rigid tube having perforations in the portion enclosing the space; and Figure 3 represents an outside view of the device of Figure 2 connected to a length of detonating fuse.

Referring now to the figures in greater detail, **1** represents a metal detonator shell having an integrally closed end **4**. Within the shell **1** and adjacent to the closed end **4** is a base charge **5** of a detonating explosive. Adjacent to the base charge **5** is the ignition charge **6**, and imbedded in the ignition charge **6** is the bridge wire **7** which connects the leg wires **8**, thus forming an electrical ignition means. The leg wires **8** are positioned within the sealing plug **9** which is crimped in shell **1**, and are covered by insulation **10**.

Below shell **1** is positioned the metal receptor shell **2** having an integrally closed end and containing an impact-sensitive charge **11**. The remainder of the interior of the shell **2** forms a chamber **12** for the insertion of the end of a length of detonating fuse. The detonator shell **1** and the receptor shell **2** are maintained in the position indicated by means of the curved strips **3** which have been cold-soldered to the walls of the shells.

In Figure 2, the arrangement is similar to that described with respect to Figure 1, except that tubing **14** having perforations **15** has been used instead of the strips **3** to position the elements, and receptor shell **2** contains a booster charge **13** of a detonating explosive in addition to the impact-sensitive charge **11**.

In Figure 3, a length of detonating fuse has been connected to the device of Figure 2, and crimped in position by peripheral crimps **17**.

The operation of the device of the present invention is as follows: When a firing current is applied to the leg wires **8**, bridge wire **7** becomes incandescent, ignition charge **6** is initiated, and in turn initiates base charge **5**. The detonation of charge **5** fragments the shell, and particles of the end **4** are directed toward the receptor shell **2**. In the absence of any interference, the particles strike shell **2** with sufficient force to initiate impact-sensitive charge **11**, which in turn, either directly or by means of booster charge **13**, produces initiation of detonating fuse **16**. If a liquid essentially fills the space between the end **4** of the detonator and the end of the receptor, and the distance is sufficient, the particles from shell end **4** will not have enough force to initiate the charge **11**, and propagation to the detonating fuse **16** will not occur.

The contour of the end **4** of the detonator shell **1** has an effect on the direction of travel of the particles formed when base charge **5** detonates. If the end is flat or rounded, a random dispersion of the particle occurs and the quantity directed toward the receptor represents only a small proportion of the shell end. When the end **4** has an inwardly directed concavity, on the other hand, the detonation wave is apparently "focused" along the axis of the detonator, and the quantity of particles directed toward the receptor is increased. The concavity need not be of sufficient depth and degree for the formation of a "jet" such as produced by conventional "shaped charges," although the formation of a jet would not be harmful. Therefore, the provision of an inwardly directed concavity in the end of the detonator shell represents a preferred embodiment in the device of the present invention.

The maximum distance over which initiation of a receptor from a detonator will occur depends primarily upon the strength of the detonator, i.e., upon the nature and quantity of the base charge. Initiation over an unobstructed space of several feet is obtainable. However, the use of such a long-length device is undesirable under most circumstances. Therefore, the minimum separation required for consistent inactivation by the presence of a fluid between a receptor and a detonator capable of consistently producing initiation over the same separation when unobstructed is the primary importance. I have found that when a separation of less than 0.5 inch is used, extremely precise construction of the device and exacting manufacture of the detonator are essential, otherwise a device is produced which may not function in the absence of a liquid or which may not fail in the presence of the liquid. When the separation is at least 0.5 inch, and preferably at least 0.75 inch, devices which perform consistently can be produced by ordinary manufacturing procedures. Ordinarily, the separation will not exceed 4 inches because greater spacing is unnecessary and causes the device to be unwieldy.

The means for holding the detonator and receptor in axial alignment and at the predetermined spacing must be rigid and penetrable by a liquid. The structures shown in Figures 1 and 2 are representative of such means. Many others, such as tubular screening, wire rods, etc. would be feasible. The means must not obstruct the space between the two metal shell ends, particularly between their centers.

The following table illustrates fully the performance of devices prepared in accordance with the present invention. In each case, the construction used was that illustrated in Figure 2. The receptor consisted of 3 grains of lead azide as the impact-sensitive charge and 10 grains of RDX as a booster charge compacted at a pressure of about 7000 pounds per square inch within an aluminum shell having an outside diameter of 0.240 inch and a bottom wall thickness of 0.023 inch. The detonator shells had an outside diameter of 0.240 inch and a bottom thickness of 0.023 inch. The bottom was headed (inwardly directed concavity) to form a cone having a 60° apex.

Table I

Test No.	Detonator			Space Between ends (in.)	Water in Space	Performance
	Base Charge [1]	Primer Charge [1]	Ignition Charge [2]			
1	2½ gr. L.A.		3 gr. L.S.	1	No	10 D 0F.
2	do		do	¾	No	10 D 0F.
3	do		do	¾	Yes	0D 10F.
4	do		do	½	Yes	0D 5F.
5	2gr. RDX	1½gr. L.A.	1 gr. L.S.	4	No	5D 0F.
6	do	do	do	1	Yes	0D 1F.

[1] L.A.—Lead azide.
[2] L.S.—Double salt of lead nitrate and a bis basic lead salt of 4,6-dinitro-ortho-cresol.

The usual base, priming and ignition compositions found in electric detonators may be used. Typical base charge compositions include tetryl, trinitrotoluene, pentaerythritol tetranitrate, RDX (cyclonite), etc. Typical priming charge compositions include nitromannite, diazodinitrophenol, mercury fulminate, lead azide, etc. Typical ignition compositions include the complex salt of lead nitrate with a lead salt of a nitrophenol, mercury fulminate, lead styphnate, tetryl-lead styphnate compositions, diazodinitrophenol nitromannite compositions, etc. Similarly, the usual impact-sensitive compositions and booster compositions may be used in the receptor. Typical impact-sensitive compositions include lead azide, mercury fulminate, lead styphnate, etc. The booster compositions include RDX, trinitrotoluene, pentaerythritol tetranitrate, etc. However, in view of the high temperatures encountered in oil wells, I prefer to use only compositions stable above 175° C. Accordingly, the preferred detonator will contain a base charge of lead azide or RDX, a priming charge of lead azide, and an ignition charge of a complex salt of lead nitrate and a basic lead salt of a nitrophenol. The preferred receptor will contain an impact-sensitive charge of lead azide or lead styphnate and a booster charge of lead azide or RDX.

In the embodiment depicted in Figure 1, lead azide has been used as both the base charge in the detonator and as the impact-sensitive charge in the receptor. Under such circumstance, no priming charge is needed nor is a booster charge because the lead azide is effective in itself. In the case of the receptor, however, I prefer to use a booster charge of RDX in conjunction with the impact-sensitive charge of lead azide in order to reduce the quantity of explosive required to initiate the detonating fuse.

The device of the present invention is not subject to ordinary climatic conditions and special handling precautions are not needed. Many obvious modifications and variations will occur to those skilled in the art, and I intend, therefore, to be limited only by the following claims.

I claim:

1. An initiation device for detonating fuse comprising a receptor having a tubular metal shell with one integrally closed end, the other end of said shell being adapted to receive detonating fuse, and at least an impact-sensitive explosive charge partially filling said closed end; an electric detonator having a tubular metal shell with one integrally closed end positioned in axial alignment with said receptor and having a base charge of a detonating explosive inside said integrally closed end, said shells and their integrally closed ends forming liquid impervious containers, the said closed ends of each facing each

other, an unobstructed space between said closed ends, and a liquid penetrable means rigidly holding said receptor and said detonator in said spaced relationship, the distance between the said closed ends of the receptor and the detonator being at least ½ inch, whereby sufficient liquid may pass through said liquid penetrable means into said unobstructed space, to prevent the propagation of detonation from said detonator to said receptor.

2. An initiation device as claimed in claim 1, wherein said receptor contains a charge of a less sensitive detonating explosive in addition to the charge of an impact-sensitive explosive.

3. An initiation device as claimed in claim 1, wherein the distance between the said closed ends of the receptor and the detonator is between ½ and 1 inch.

4. An initiation device for detonating fuse comprising a receptor having a tubular metal shell with an integrally closed end and at least an impact-sensitive explosive charge partially filling said shell at said closed end, the other end of said shell being adapted to receive detonating fuse, an electric detonator having a tubular metal shell with an integrally closed end which has an inwardly-directed concavity and containing a base charge of a detonating explosive inside said integrally closed end, said shells and their integrally closed ends forming liquid impervious containers, said detonator being in axial alignment to said receptor, the said closed ends of each facing each other, an unobstructed space between said closed ends, and a liquid penetrable means rigidly holding said receptor and said detonator in said spaced relationship, the distance between the said closed ends of the receptor and the detonator being at least ½ inch, whereby sufficient liquid may pass through said liquid penetrable means into said unobstructed space, to prevent the propagation of detonation from said detonator to said receptor.

5. An initiation device as claimed in claim 4, wherein said means for holding said receptor and detonator in said spaced relationship comprises a plurality of strips.

6. An initiation device as claimed in claim 4, wherein said means for holding said receptor and detonator in said spaced relationship comprises a tubular connecting piece containing a plurality of openings.

7. An initiation device for detonating fuse comprising a receptor having a tubular metal shell with one integrally closed end, an impact-sensitive charge within said shell adjacent to said end, and a detonating charge of a less sensitive charge adjacent to said impact-sensitive charge, the other end of said shell being adapted to receive detonating fuse, an electric detonator having a tubular metal shell with one integrally closed end, said end having an inwardly directed concavity, said shells and their integrally closed ends forming liquid impervious containers, a base charge of a detonating explosive within said shell adjacent to said closed end, an ignition charge of an initiating explosive adjacent to said base charge, electrical initiating means in initiation relationship to said igniton charge, and a plug sealing said shell, said receptor and said detonator being in axial alignment with the integrally closed end of one facing that of the other, an unobstructed space of at least ½ inch in length between said receptor and said detonator; and a rigid tubular element surrounding both said receptor and said detonator, said element having a plurality of openings in that portion surrounding said space, whereby sufficient liquid may pass through said liquid penetrable means into said unobstructed space, to prevent the propagation of detonation from said detonator to said receptor.

8. A device as claimed in claim 7, wherein all of said explosive charges are stable at temperatures up to at least 175° C.

9. A device as claimed in claim 7, wherein the impact-sensitive explosive charge is lead azide.

10. A device as claimed in claim 7 wherein the ignition charge is lead azide.

11. A device as claimed in claim 7, wherein the detonating charge adjacent to the impact-sensitive charge in the receptor shell is RDX.

12. A device as claimed in claim 7, wherein said tubular element is of metal.

13. A device as claimed in claim 7, wherein said tubular element is of metal and is crimped about the plug-containing end of said detonator.

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