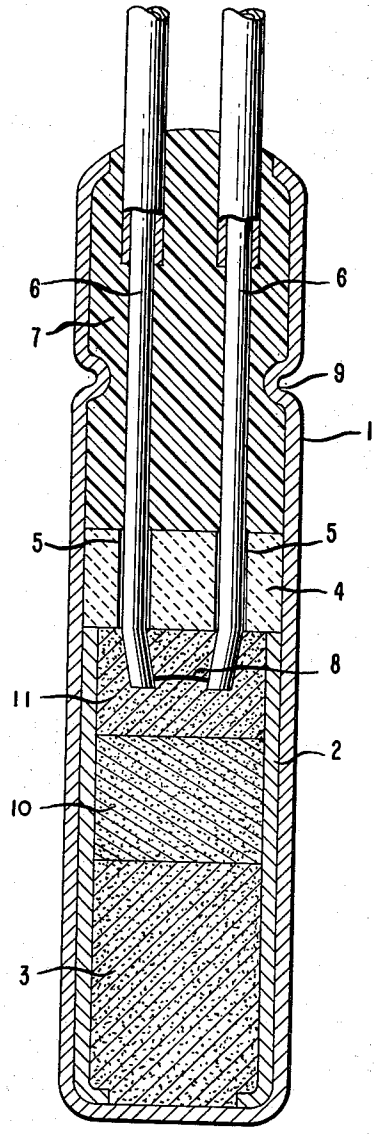
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P. J. BRYAN

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WATER IMPERVIOUS DETONATOR

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INVENTOR

PAUL JOHN BRYAN

BY John H. Tregoning

ATTORNEY

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WATER IMPERVIOUS DETONATOR

Paul John Bryan, Hewitt, N.J., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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The present invention relates to electric initiators for explosives and, more particularly, to sealing means for such initiators with unusual resistance to the ingress of water and to extremes of pressure and temperature.

Conventionally, electric initiators are assembled with insulated leg wires positioned and secured by a plug of rubber or a plastic composition. The plug is held in place within the open end of the metal shell or capsule by a seal formed by thermoplastic compositions or by crimping the shell wall into the body of the shell. Such sealing means are, in general, adequate when the initiator is to be used at atmospheric pressure and at moderate temperatures. However, they fail under conditions of elevated temperature and pressure since the plug becomes plastic and flows under the existing pressure into the shell where it desensitizes the explosive initiator compositions and the weakened seal allows the ingress of fluids which further desensitize the initiator. The extreme pressure further acts to push the plug down into the shell and to permit the ingress of further desensitizing fluids.

Prior attempts to overcome these difficulties have involved the use of a dielectric plug, e.g., of ceramic, which is soldered into place within the shell and covered by an insulative material. The provision of such a seal involves inconvenient and time-consuming assembly techniques and greatly adds to the cost of the initiator. Additionally, it is extremely difficult to provide a completely pressure resistant seal by soldering, and leaks which develop within the soldered portion of the seal allow desensitizing fluids to flow into the shell.

In accordance with this invention in an electric initiator adapted for use at elevated temperatures and pressures comprising a shell having one closed and one open extremity, explosive charges positioned within the shell and an ignition assembly sealed within and closing the open extremity of the shell, the improvement for providing an effective hydraulic seal under conditions of high temperature and pressure comprises a shell liner positioned between the closed extremity of the shell and the ignition assembly, and a closure element supported by and closing the extremity of the shell liner contiguous to the ignition assembly, said closure element being provided with openings to allow passage therethrough to the lead wires of the ignition assembly.

In the preferred embodiment, the shell liner will be in continuous, snug, peripheral engagement with the inner surface of the shell wall, i.e., it will conform to the shape of the shell, and the closure member will be a wafer of refractory material having an outer circumference conforming substantially to the inner circumference of the shell wall. The joinder of the closure element and the rim or edge of the shell liner will be such that continuous contact between the two is provided and a firm seat is established.

The provision of the combination of a wafer of refractory material resting on and supported by the rim of a shell liner, as just described, overcomes the aforementioned difficulties which arise at elevated temperatures and pressures since, under these conditions, the effective hydraulic seal is provided. With regard to the conventional initiator assembly contained by a rubber or plastic plug designed to seal the open end of the initiator, the conditions of temperature and pressure which act to cause

the plug to become plastic, thus encouraging the undesirable results described above, are, in the instant case, of paramount importance in effecting the hydraulic seal and are thus conducive to producing the desired results of this invention. The combination of high pressure and high temperature act on the plug to plasticize the material itself and to force the plug and the ignition assembly as a whole inward toward the wafer of this invention. The pressure exerted by the plug on the wafer causes a tight, immobile contact between the wafer and the rim of the shell liner while the plastic material of the plug works to complete a hydraulic seal by occupying and sealing those openings and crevices in the wafer and between the wafer and the shell wall which might otherwise have allowed desensitizing fluids to contact the explosive composition housed within the initiator.

In order to describe the invention more clearly, reference is made to the accompanying drawing (FIGURE 1) which is a cross sectional view of a complete assembly of an electric blasting initiator. It is to be understood that the drawing is presented solely by way of illustration and is not to be regarded as limiting the scope of the invention.

Referring to the drawing, the electric blasting initiator consists essentially of a shell which has one closed and one open extremity. A shell liner **2** disposed within the lowermost portion of the shell is in snug peripheral engagement with the inner wall of the shell. Initiator charges consisting of a base charge **3** of detonating explosive, a priming explosive charge **10**, and an ignition charge **11**, are placed in the lined portion of the shell **1**, in sequence from the integrally closed extremity of the shell. Wafer **4** of a refractory material rests on the upper rim of the shell liner **2**. The wafer **4** is provided with properly spaced apertures **5** for the passage of the bared ends of lead wires **6**. Above the refractory wafer is a suitable insulating and sealing plug **7** in which both the bared ends of lead wires and the terminal insulation about the lead wires are imbedded. A bridgewire **8** spans the terminal ends of the lead wires within the shell. Circumferential crimps **9** in the shell maintain the sealing means in proper position.

The assembly of this invention provides an electric initiator for explosives of improved resistance to deformation and to the resultant fracture of the sealing means. Resistance to temperature is limited only by the physical characteristics of the initiation compositions and structural materials used and the wire insulation employed. A hydraulic seal is formed between the closure plug and the shell which is resistant both to ingress of fluids and to elevated temperatures and pressures. The ability to withstand exposure to elevated temperatures and pressures is a desirable characteristic for initiating explosives used in oil well perforating devices, in rocket applications, in tapping steel furnaces and other environments involving exposure to high temperature and pressure.

In actual operation, the refractory member **4** serves to support the sealing member **7** and to hold it securely in place. There is no need to provide supplemental sealing or bonding element between the dielectric member and the lead wires or between the dielectric member and the shell. The use of supplemental elements greatly adds to the cost of the device and necessitates time-consuming and inconvenient assembly techniques.

The refractory member may be of silicon dioxide, e.g., porcelain, aluminum oxide, e.g., alumina, chromium oxide, magnesium oxide, zirconium oxide, a thermosetting resin and the like. Such materials are relatively cheap, have a high degree of heat resistance and can be readily formed into the desired shape for convenience of assembly into the initiators. The wafer of refractory

material should be of such size and configuration that the outer circumference conforms to the inner circumference of the shell wall and is in relatively snug peripheral engagement therewith. Obviously, the exact diameter or width of the wafer will depend upon the size of the initiator in which it is to be used and this in turn depends upon the requirements of the initiator. The wafer should be thick enough to withstand the pressure exerted thereon when the initiator is under elevated pressure. In general, a refractory wafer about ¼ inch in thickness supported on the rim of a shell liner will be sufficient to withstand a pressure as great as 15,000 p.s.i.

Preferably, the material used for the shell and the shell liner is of thin gage commercial bronze or another copper alloy, copper, or aluminum, although other metals or polymeric materials having the requisite structural strength and requisite thermal stability may be used as well. The shell liner should provide an edge wide enough to support the wafer at the pressure under which the initiator is to be used. In general, the liner thickness will be 0.03 inch. In addition to supporting the refractory wafer, the liner adds structural strength to the shell walls and prevents their collapse at elevated pressures.

A variety of ignition assemblies can be sealed within the shell. Exemplary assemblies are a bridgewire and bead arrangement, a bridgewire inserted into a mass of loose ignition composition, an exploding bridgewire unit and an arc-firing system in which the bridgewire is eliminated. The ignition assembly may be actuated by lead wires extending to a conventional blasting circuit.

To provide delayed firing action, e.g., for sequential blasting assemblies, a conventional thermally stable delay train consisting essentially of a length of a gasless deflagrating composition within a heavy-walled tube may be incorporated within the shell, e.g., between ignition assembly and the primer charge.

Any ignition and priming compositions which can withstand the temperatures of which the device is anticipated to be used can be used in this initiator. As the base charge may be used either a detonating explosive composition or a deflagrating explosive composition, depending upon whether a detonator or squib action is desired.

The following example is illustrative of the nature of the present invention, but it is to be understood that the invention is not limited thereto.

Example

An initiator was assembled as shown in the accompanying drawing. A tubular shell liner 2 of commercial bronze, approximately 0.614 inch long, and having an inner diameter of 0.227 inch and an outer diameter of 0.259 inch was placed in a shell 1 of bronze, 1.223 inch long, having an outer diameter of 0.299 inch and an inner diameter of 0.259 inch. Into the base of the so assembled shell and liner was loaded 4.1 grains of a loose detonating charge consisting essentially of graphited RDX, and the charge was pressed at 250 pounds pressure. A primer charge consisting essentially of 5.0 grains of lead azide was pressed into place above the detonating charge by 250 pounds pressure. A loose ignition charge consisting essentially of 1.8 grains of coarse lead dinitro-orthocresol was loaded above the primer charge.

The ignition assembly was made as follows: A pair of insulated lead wires 0.060 inch in diameter having the lower portion thereof uninsulated were molded into a plug 0.250 inch in diameter and consisting essentially of a conventional neoprene plug composition. The uninsulated wires projecting from the ignition end of the plug then were passed through apertures, 0.036 inch in diameter, in a ceramic disc, 0.253 inch in diameter, 0.125 inch thick, consisting of 94% alumina and 6% of a binder consisting of manganous oxide and silicon dioxide. The lead wires extended 0.078 inch beyond the base of the disc. A bridgewire, 0.0015 inch in diameter, of a 80/20 nickel/chromium alloy was soldered to the terminal ends of the lead wires. This ignition assembly was inserted to the loaded shell and sealed into place by two circumferential crimps around the portion of the shell opposite the plug.

The so assembled initiator withstood a pressure of 15,000 p.s.i. and 325° F. for ½ hr. and fired reliably when an electric blasting current was applied to the lead wires.

It will be seen that in accordance with the foregoing description of this invention, a compact, rugged initiator which is able to withstand elevated temperatures and pressures has been provided. The detailed description has been given for clearness of understanding only and no undue limitations are to be constructed therefrom. The invention is not limited to the exact details shown and described since various modifications which do not materially alter the basic character of the invention or depart from the spirit and principle of the invention will occur to those skilled in the art. We intend, therefore, to be limited only by the following claims.

What is claimed is:

1. In an electrical initiator comprising an imperforate tubular shell having one open and one closed end, explosive charges within the shell, and lead wires extending through and from an insulating plug which seals the open end of the shell,

means operating in conjunction with the insulating plug to provide an effective hydraulic seal between the explosive charges and the open end of the shell under such conditions of temperature and pressure that said plug is plastic comprising:

(*a*) a rigid tubular shell liner fixedly positioned between the closed end of the shell and the insulating plug, and

(*b*) a closure element of heat- and pressure-resistant material closing and being supportably seated on the end of the shell liner nearest the insulating plug in a position contiguous to said plug, the circumferential surface of the closure element conforming substantially to and being in peripheral engagement with the internal surface of the shell, said closure element being provided with openings therethrough for said lead wires,

said explosive charges being between said closed end of the shell and the closure element.

2. The combination of claim 1 wherein the closure element is a wafer of refractory material.

3. The combination of claim 1 wherein the shell liner is in continuous snug peripheral engagement with the shell wall and the closure element is a wafer of refractory material.

4. In an electrical initiator comprising an imperforate cylindrical shell having one open and one closed end, explosive charges including an ignition charge within the shell, lead wires extending through and from an insulating plug which seals the open end of the shell, and a bridgewire contacting said ignition charge and connecting the ends of the lead wires within the shell,

means operating in conjunction with the insulating plug to provide an effective hydraulic seal between the explosive charges and the open end of the shell under such conditions of temperature and pressure that said plug is plastic comprising:

(*a*) a rigid cylindrical shell liner fixedly positioned in continuous snug peripheral engagement with the interior surface of the shell and extending from the closed end of the shell to a position closely adjacent the insulating plug, said shell liner housing said explosive charges, and the end of the shell liner adjacent said plug providing a circular rim, and

(*b*) a cylindrical wafer of refractory material seated on, supported by, and in continuous contact with said rim in a position contiguous to said plug, the circumferential surface of said wafer being in continuous snug peripheral engagement with the internal surface of the shell and being provided with openings therethrough for said lead wires.

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