Oct. 5, 1943. W. TAYLOR ET AL 2,331,007

MANUFACTURE OF ELECTRIC DETONATORS

Filed Feb. 28, 1940

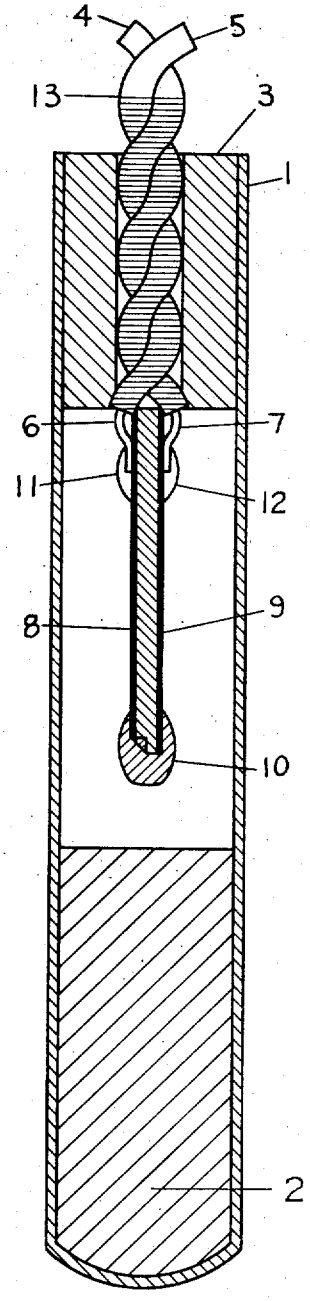

FIG. 1

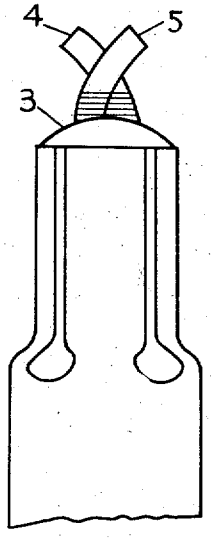

FIG. 3

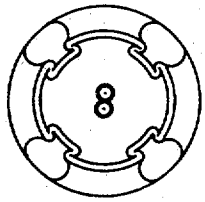

FIG. 4

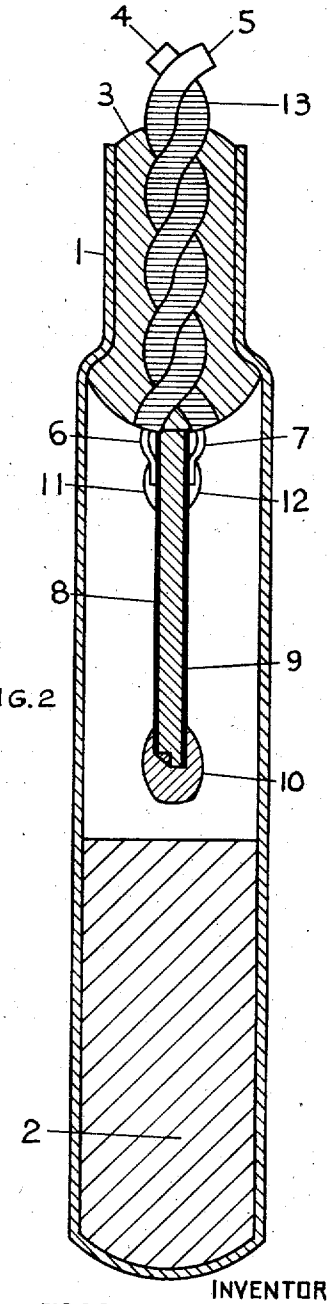

FIG. 2

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MANUFACTURE OF ELECTRIC DETONATORS

Wilfrid Taylor, Saltcoats, Scotland, and Maldwyn Jones, Manchester, England, assignors to Imperial Chemical Industries Limited, a corporation of Great Britain

Application February 28, 1940, Serial No. 321,302
In Great Britain March 3, 1939

10 Claims. (Cl. 102—28)

In the manufacture of electric detonators, it is known to effect the sealing by crimping the metal detonator tube onto a vulcanised indiarubber plug through which the electric conductors pass into the interior of the detonator.

Vulcanised indiarubber does not become appreciably plastic when it is exposed to warm temperatures or relatively high pressures such as are experienced in storage or in blasting practice, but retains its outstanding resilient properties under these conditions. As long as the material of the plug is in good condition it therefore maintains a continuous pressure against the conductors and the wall of the detonator tube into which it is crimped. So long as the indiarubber remains in good condition, vulcanised indiarubber plug detonators are thus remarkably free from the type of failure due to the entry of water or moisture. Vulcanised indiarubber, however, as is well known, sooner or later perishes and becomes brittle; and under warm storage conditions the life of the vulcanised indiarubber plug electric detonator is somewhat shorter than is generally considered desirable for electric detonators. For some applications of electric detonators, moreover, especially blasting in fiery mines, it is desirable that the sealing material employed should be of low inflammability, and preferably less inflammable than rubber.

Although many materials are known which either have better storage properties or are less inflammable than indiarubber, it has hitherto been impossible to produce crimped plug electric detonators capable under service conditions of resisting the entry of water into the interior as effectively by the use of compositions free from indiarubber as by the use of compositions containing indiarubber.

We have now found that by crimping the charged detonator tube over a plug of resilient material based on vulcansed polymerised 2-chloro-butadiene 1:3 (a material known as neoprene) through which the twisted insulated electric conductors extend towards the electric initiating element to which they are attached, we can produce an electric detonator which can not only be stored without deterioration for much longer periods under good or even bad storage conditions than vulcanised indiarubber plug electric detonators, but which can also adequately resist the entry of water under a wide range of pressure conditions, even after prolonged exposure to warm storage. We may therefore employ lead azide charges in copper tubes; a combination which has hitherto been avoided because of the formation of traces of the dangerously sensitive cooper azide in presence of traces of moisture. The neoprene compositions are also less inflammable than vulcanised indiarubber.

In putting the invention into effect, we may employ the neoprene compounded with other ingredients. In the case of detonators intended to be used in fiery or gassy situations, the compounding ingredients of the neoprene composition may include organic ingredients of flame-quenching, non-inflammable or but slightly inflammable character, for instance, waxy chlorinated hydrocarbons. The insulated covering of the electric conductors leading to the electric initiating element of the detonator is left intact at the position occupied by the neoprene composition plug.

According to one form of the invention the neoprene composition is extruded into the form of a perforated tube before vulcanisation is carried out or completed and the plugs are fashioned by cutting the extruded tubes into lengths and threading the insulated conductors through the vulcanised tubes. It is convenient to vulcanise the tubes before cutting them.

According to another form of the invention the neoprene composition in its still thermoplastic unvulcanised or only partly vulcanised condition is first moulded under pressure at raised temperature around the axially disposed insulated and twisted conductors into a form having a cylindrical surface and is vulcanised thereafter to form structures in which the insulated and twisted leading wires are firmly embedded in plugs of vulcanised neoprene composition.

In the drawing attached hereto, Fig. 1 is a longitudinal section of a charged detonator in which a tubular neoprene composition plug, bearing the insulated conductors to the stripped ends of which a fuzehead has been attached, is positioned ready for crimping; Fig. 2 represents a longitudinal section of the detonator after the plug has been crimped, and Figs. 3 and 4 represent respectively a side view and plan of the crimped end of the detonator. In the drawing 1 represents the detonator tube containing an initiating charge 2. 3 represents a cylindrical plug of neoprene composition through which the insulated portions 4 and 5 of the electric conductors pass. The stripped ends 6 and 7 of these conductors are attached to the poles 8 and 9 of the fuzehead 10 by spots of solder 11 and 12. The resin-wax coating 13 on the insulated conductors 4 and 5 extends slightly above the top of the plug. In Fig. 2, the general reduction in diam-

eter of the crimped portion of the detonator tube and the corresponding extension in length of the neoprene composition plug are shown. The nature of the crimp is shown in greater detail in Figs. 3 and 4.

The ends of the conductors to which the electric initiating element is to be attached may conveniently be stripped after the plug has been positioned over the twisted conductors, but if desired they may be stripped beforehand. In either case, the insulation preferably extends somewhat below the base of the plug in the complete assembly, and the plug should extend over more than one complete twist.

Since according to the present invention the waterproofing effect depends on the efficient compression by the crimp of the resilient plug against the wall of the detonator tube and against the conductors passing through it, an efficient type of crimp is necessary.

A crimping apparatus especially suitable for the manufacture of electric detonators according to the present invention first grooves the tube longitudinally around the plug to form a quatrefoil section, then flattens the lobes of the quatrefoil radially to form a substantially cylindrical neck of reduced radius on the tube; the superfluous metal being forced into a flattened sigmoid fold at each side of each groove.

The electric initiating element may conveniently take the form of an electric fuzehead of the kind in which the initiating composition is a coherent bead.

It has been proposed to form a crimped plug electric detonator in which a vulcanisable thermoplastic composition having resilient properties is moulded around the separate and partly bared leading wires into the form of a plug having an extension of reduced cross section, in such a manner that the extremities of the insulation are enclosed in the plug, and the bare portions of the wire protrude through the extension. According to this proposal the vulcanisable composition may be vulcanised during the moulding operation.

The present invention, however, presents the advantage that the insulation of the detonator leading wires may be continued beyond the plug into the body of the detonator, thereby minimizing the risk of stray current ignition and allowing of the attachment of a ready made fusehead; and also that it facilitates the stripping of the ends of the insulated wires.

According to that form of the invention in which the vulcanised plug is threaded on to the insulated conductors the twisting may be carried out before or during the twisting operation. According to that form of the invention in which the plug is moulded about the twisted and insulated wires the moulding operation may conveniently be carried out in a multiple unit mould to produce at each operation a number of plugs in which twisted insulated leading wires are embedded. The insulated leading wires may be already cut and twisted, and if desired also the insulation may be already stripped from their ends, or the twisted wires may be in the form of a continuous length passing through each unit of the mould. The plugs moulded round the twisted insulated wires may be removed from the moulds as soon as they have set sufficiently to retain their shape, and the vulcanisation is thereafter accomplished or completed by stoving, storage or otherwise, depending on the vulcanisation characteristics of the neoprene composition employed. The severance of the leading wires between the adjacent plugs and the removal of the insulation from their extremities, if required, and the attachment of the primary electrical ignition means, e. g. the bridge wires or fuzeheads, may be carried out in any suitable succession of steps after the plugs have been moulded about the leading wires, due regard being paid to the nature of any vulcanisation treatment required; and the loaded detonator tubes are finally crimped around the plugs carrying the leading wires to which the primary ignition means have been attached.

The mould may conveniently be made in two portions each containing a number of cavities cooperating to define cylindrical unit cavities at intervals around suitably guided axially situated twisted insulated leading wires, suitable means being provided whereby the twisted leading wires may be distanced as desired between adjacent cavities, so that a continuous length of wire may be employed. But if twisted lengths of insulated leading wires previously cut to a desired length are used, the distancing means may be omitted. The mould is provided with arrangements whereby the cavities can be heated, and if desired also it may be provided with means whereby they can be chilled. The neoprene composition may be introduced into the cavities in the form of strips, lumps or the like in such quantity that when the mould is closed and pressure is applied the composition will be forced into intimate contact with the twisted leading wires running axially through the cavities, and provide an excess over what is required to complete the cylinder. Provision may be made for the surplus to flow axially or in some other convenient direction to form a flash.

Alternatively, if desired, an injection type of moulding apparatus may be employed, but in this case the neoprene composition employed must be such that it will not set during the period for which it is present in the apparatus.

The invention is further illustrated by the following example in which the parts are parts by weight:

Example 1

	Parts
Neoprene	100
Magnesium oxide	10
Wood rosin	5
Zinc oxide	10
Nonox S (registered trade-mark)	2
Polychlor-naphthalene (melting 68° C.)	5
Cotton-seed oil	5
Vulcanised rape-seed oil	20
Whiting	120
Titanium dioxide	10
Vulcafor Yellow G. S	3

The above ingredients are extruded under pressure in a heated extrusion apparatus, through a die having internal diameter of approximately 4.5 mm. with a tapering centre pin, into the form of tubing. As it comes past the die the material swells, so that the external diameter is about 5.2 to 5.5 mm. and the central orifice about 1.5 to 2.0 mm. The tubing is vulcanised by heating it in an autoclave at 40 lb. steam pressure about 140° C. for one hour, and is then cut into lengths of about 8 mm. The leading wires, already provided with a suitable insulation and twisted together, are then threaded through the central hole in the plug, with the aid of a little talc, and the fuzehead is attached to the bared ends of

these wires. The fuzehead and leading wires are waxed in a resin-wax bath at about 130° C. for a suitable distance, and the plug is then slipped over the waxed wires while the wax is still fluid, and adjusted to its proper position against the fuzehead. The plug is then inserted to a suitable depth into the end of a No. 6 fulminate-chlorate copper detonator of which the diameter at the mouth is approximately 5.97 mm. and crimped mechanically with multiple crimps so as to pinch the walls of the detonator deeply into the plug and make a tight joint also with the crimped leading wires. The detonator of this example can be used in fiery mines. It can also be used for submarine blasting.

Example 2

Quantities of the composition used according to Example 1, each more than sufficient to form the cylinder, are introduced into the cavities of one plate of a mould of the separable type in which the twisted insulated leading wires have been positioned. The mould cavities are shaped so as to permit surplus material to escape axially at one end to form a flash when the other plate of the mould is pressed home. The temperature of the mould is approximately 160° C. and the mould remains closed under pressure for one minute. It is then opened and the twisted leading wires with their adhering plugs, which have been set in shape by their incipient vulcanisation, are withdrawn. The plugs with the leading wires are then placed in a stove and heated by means of live steam at 40 lb. pressure at approximately 140° C. for one hour, by which time they are satisfactorily vulcanised. The diameter of the cylindrical portion of the plugs including the wires is such as to permit of their being just entered without difficulty into a No. 6 detonator tube. The depth of the cylindrical portion of the plug is about 8 mm. The wires are cut at a distance of about ¾" from the end of each plug opposite to the flash. The insulation is stripped from the greater part of the short end of the wires and also from the remote ends of the wires. The flash is trimmed. Fuzeheads are then soldered on to the short bared ends and charged No. 6 detonator tubes are crimped around the plugs by means of a Briese crimp.

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:

1. An electric detonator in which the insulated electric conductors leading to the electric initiating element are twisted together and pass through a resilient electric plug comprising vulcanised polymerised 2-chloro-butadiene-1:3 crimped into the mouth of the charged detonator tube.

2. A detonator as claimed in claim 1 in which the initiating element is in the form of a head bead.

3. A detonator as claimed in claim 1 in which the 2-chloro-butadiene-1:3 composition contains organic ingredients of a flame-quenching, non-inflammable character.

4. A process for sealing an electric detonator, which process comprises positioning about the insulated and twisted electric conductors a sealing plug of resilient material comprising vulcanised polymerised 2-chlorobutadiene-1:3, attaching the electric initiating element, and crimping the plug with the conductors and initiating element in position into the mouth of the charged detonator tube.

5. A process as claimed in claim 4 in which a tubular plug of vulcanised 2-chloro-butadiene-1:3 is first formed and then threaded on to the insulated conductors.

6. A process as claimed in claim 5 in which the 2-chloro-butadiene-1:3 composition is extruded into the form of a tube and is subsequently vulcanised and cut into lengths.

7. A process as claimed in claim 4 in which the plug is moulded about the twisted insulated conductors.

8. A process as claimed in claim 7 in which the vulcanisation of the 2-chloro-butadiene-1:3 composition is carried out after it has been moulded about the twisted wires.

9. A process as claimed in claim 4 in which the ends of the conductors protruding through the plug are stripped and trimmed after positioning the sealing plug on the conductors.

10. A detonator as claimed in claim 1 wherein the tube is crimped to the resilient plug by grooving said tube to form a quatrefoil section flatttening the lobes of said quatrefoil radially to form a substantially cylindrical neck of reduced radius and forcing the superfluous metal into a flattened sigmoid fold at each side of each groove.

WILFRID TAYLOR.
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CERTIFICATE OF CORRECTION.

Patent No. 2,331,007. October 5, 1943.

WILFRED TAYLOR, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 10, strike out the word "head"; line 29, for "claim 5" read --claim 4--; line 36, for "claim 7" read --claim 4--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of November, A. D. 1943.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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