

AN ELECTRONIC DETONATION CONTROL CIRCUIT

The invention relates to an electronic detonation control circuit, for example, for a munition.

A detonation control circuit, by means of which, from a number of detonation sensor signals by way of the logic combination thereof, a detonation release signal is obtained for an electrical detonating means is for example known from German Auslegeschrift No. 26 03 067.

In the course of trials with a detonation control circuit comprising a logic circuit fed from a power source, for obtaining a detonation release signal from a combination of detonation sensor or input signals, and an electrical detonating means which is controlled, armable or releasable by means of a switching member which is electronically controlled or reversible by the detonation release signal, it has become apparent that when particularly unfavourable limiting or marginal conditions, more especially at the commencement of operation of the power source (for example incorporated into a projectile and activatable only with the firing) arise, the logic circuit may prematurely or transiently, in other words without the existence of the preset combination input signal criteria, assume states which lead to output signals which act on the switching member as detonation release signals. These non-reproducible initial or transient states of the logic circuit can occur whenever it is not supplied with a minimum operating voltage for orderly mode of operation of its logic elements.

In recognition of this factor, a problem underlying the invention is to provide such a detonation control circuit with a simple and operationally reliable, easily checkable safety measure which is adaptable in an optimum manner to the respective operating voltage factors of the logic circuit and which reliably suppresses such apparent detonation release signals and thus a premature release by the electrical circuit of the detonating means.

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It is generally proposed to solve this problem by providing an electronic detonation control circuit, comprising electronic logic to derive, from a plurality of inputs, a detonation release signal to actuate or ready electrical detonating means via an electronic switching member, with safety means comprising electronic blocking means to prevent said detonation release signal reaching or actuating said electronic switching member; and threshold means, responsive to the electrical supply to the electronic detonation control circuit reaching a predetermined operational voltage, to inhibit the preventative action of said electronic blocking means.

The present invention provides an electronic detonation control circuit comprising a logic circuit, fed from a power source, and arranged to provide a detonation release signal from a combination of detonation sensor or input signals, and an electrical detonating means which is controlled, armable or releasable by means of a switching member which is electronically controlled or reversible by the detonation release signal, characterised in that connected prior to a control input for the switching member is an electronically controllable blocking section which is blockable or actuatable by way of a nominal-voltage threshold-value circuit connected to the power source, whereby to cause the blocking section to block the control input until the power source achieves a predetermined nominal voltage.

Thus, connected prior to the switching member, in the circuit for the detonating means, there is an electronically controllable blocking section for blocking (actual and more especially premature) apparent detonation release signals from the logic circuit, which blocking section is switchable into an ineffective state only by way of the voltage threshold value circuit, so that it is readily ensurable that any control of the switching member from the logic circuit is prevented so long as the output voltage, monitored by means of the threshold value circuit, of the power source still lies below the voltage level which indispensably has to be ensured for the orderly operation of the logic circuit as the minimum operating voltage thereof, to effect said safety measure.

The safety measure, in accordance with the invention, merely requires, for example, two non-linear divider circuits formed from a complementary signal shunting transistor and longitudinal (series) signal resistance connected in front of a base of a transistor serving as the switching member, and, in front of the base of this shunting transistor, a voltage threshold member which switches in a voltage-dependent manner and is in circuit with transverse (series) resistance.

10 By additional voltage rise delay circuitry at the input of this threshold member there emerges a delayed release of the switching member for the detonating means and thus, in circuit-technology respects, a simple possibility for extending the described protective measure, to the effect that additional time safety devices with
15 respect to the earliest possible release or triggering instant of the detonating means, such as for the barrel and pre-barrel safety in the case of a projectile, are realisable and are dimensionable within wide limits.

20 Additional further developments and alternatives as well as further features and advantages of the invention will become apparent from the sub-claims as well as from the following description of a typical exemplified embodiment of the invention which is shown in a highly simplified manner in the drawing.

25 The single Figure of the accompanying drawing is a basic circuit diagram of an electronic detonation control circuit, taking into account the protective measures, in accordance with the invention, employing, in this example, bipolar transistors.

30 The electronic detonation control circuit 1 has a logic circuit 2 in which detonation sensor signals 3, obtained for example by means of various pick-ups by virtue of different physical effects, are combined with one another, in accordance with specific target criteria upon
35 appropriate approach to a target object, to obtain a detonation release signal 4 which, via an electronically reversible switching

member 5, arms or makes live or otherwise releases an electrical detonating means 6 for the detonation of an effective charge for attaching a target.

5 The detonating means 6 can be fed from an adapted current or voltage source, for example, from a piezogenerator 7 energised as a result of target impact or from a steadily acting power source 8. In any event for the operational supply of the logic circuit 2 such a power source 8 is provided which can be, for example, a launch-
10 activatable battery, a piezogenerator energised as a result of the firing acceleration of a projectile, a thermogenerator energised by projectile-flight frictional heat or a wind wheel generator.

Upon use of any of all the power sources 8 which are in practice
15 suitable, it has been ascertained that the steady voltage is not available suddenly and at a reproducibly ascertainable instant as from being put into operation, but builds up more or less slowly, due firstly to the physical mode of operation of such a power source 8, and secondly to the fact that at the output side at all times stray
20 capacitances 9 are effective which, together with an internal or wiring resistance 10, have the effect of a voltage-rise delay member 11.

At any event there is thus not available instantaneously from the
25 power source 8 a supply voltage at the logic circuit 2 which lies above the minimum operating voltage necessary for reproducibly predeterminable logic functioning of the interconnected gates of the logic circuit 2. Thus, in practice such logic circuits 2 would normally suffer from irregular behaviour by reason of initial
30 operation by the undervoltage to give random or undefined outputs from the logic circuit 2; and thus, through the detonation-sensor input signals 3, could trigger incorrect or spurious detonation release signals 4 which are totally unrequired. Any such incorrect detonation signal is a safety risk especially when so controlled articles of
35 munition are transported, because premature actuation of the detonating means 6 is transiently possible.

In order reliably to block actuation of the detonating means 6 by reversal of the switching member 5 so long as the operating voltage for reproducible mode of operation of the logic circuit 2 is still not achieved, connected prior to the control input 12 of the switching member 5 is an electronically controllable blocking section 13. This section 13 releases the control of the switching member 5 to the logic circuit when, and only when, it responds to the necessary operating voltage for the logic circuit 2 from the power source 8 being achieved.

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In this way the release of the electric detonation circuit by way of the detonating means 6 remains blocked (and any premature detonation by reason of an apparent release signal 4 given off prematurely, by the still not regularly working logic circuit 2, is reliably prevented) until the logic circuit 2 is supplied from the power source 8 with adequate operating voltage and is in reliable operation.

For reasons of the operating reliability of this protective measure, the blocking section 13 is preferably not designed as an interrupted, e.g. a normal open switch, in the signal line to the switching member 5, but is preferably arranged to serve as a signal shunt. In this embodiment the blocking section is a non-linear voltage divider circuit with a shunting member 14, parallel to the control input 12 of the switching member 5, which is self-conducting in the rest state, which shunting member 14 may be in series with a signal limiting resistor 21.

This electronic shunting member 14 is made response to the voltage from the power source 8 by a nominal-voltage threshold-value circuit 15 which reacts to the nominal operating voltage for the orderly functioning of the logic circuit being reached or exceeded to reverse, i.e. block, the shunting member 14. The threshold value circuit 15 may simply be a second non-linear voltage divider comprising a resistor 17 in series with a component part having a voltage threshold characteristic, for example a Zener diode 16, in the

longitudinal branch, the resistor 17 being disposed in the transverse branch, i.e. parallel to the control of the subsequently-connected blocking section 13. Only when by reason of appropriate voltage level from the power source 8 does the Zener diode 16 become conductive to cause the shunting effect of the blocking section 13 to be cancelled, so that the switching-member control input 12 becomes controllable by the logic circuit 2.

For further safety against premature control of the detonating means 6, for example for pre-barrel safety in the case of a projectile, merely a delay device 18 needs to be connected prior to the threshold value circuit 15. This is exemplified in the drawing as a low-pass device consisting of a transverse capacitotr 19, in parallel with the circuit 15, and barrier resistance 20, in series with the circuit 15.

With particularly little circuitry-technology extra expenditure with high operating reliability, the protective measure in accordance with the invention can be realised in a detonation control circuit 1 if the switching member 5 lies in series with the detonating means 6 and both the switching member 5 and the shunting member 14 are constructed as complementary transistors (shown in the circuit for positive operating voltage from the power source 8 with bipolar transistors). This is because then at all times (prior to adequate voltage for the switching through of the threshold value circuit 15 which is designed for minimum operating voltage for the logic circuit 2) the base of the shunting member 14 is applied by way of the resistor 17 to collector potential, so that the shunting member 14 is reliably conductive. Therefore the control input 12 is short-circuited, in other words the switching member 5 is reliably blocked and is also not controllable by way of any spurious output signals from the logic circuit 2 by way of the protective resistor 21. Only when the collector/emitter section of the shunting member 14 is highly resistive (because conduction through the Zener diode 16 applying the sufficiently risen operating voltage from the power source 8 to the base of the member 14) is the shunting short-circuit at the control

input 12 cancelled, and can the switching member 5 become reversed (by a detonation release signal 4 emitted from the logic circuit 2) to a detonation readiness state in which a or the circuit through or to the detonating means 6 is activated or completed to permit the detonating means 6 to detonate a charge.

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CLAIMS

1. An electronic detonation control circuit comprising a logic circuit, fed from a power source, and arranged to provide a detonation release signal from a combination of detonation sensor or input signals, and an electrical detonating means which is controlled, armable or releasable by means of a switching member which is electronically controlled or reversible by the detonation release signal, characterised in that connected prior to a control input for the switching member is an electronically controllable blocking section which is blockable or actuatable by way of a nominal-voltage threshold-value circuit connected to the power source, whereby to cause the blocking section to block the control input until the power source achieves a predetermined nominal voltage.
2. An electronic detonation control circuit as claimed in Claim 1, characterised in that the blocking section has a self-conducting shunting member which lies in parallel with the control input of the switching member.
3. An electronic detonation control circuit as claimed in Claim 1 or 2, characterised in that the control input of the switching member lies in series with the detonating means.
4. An electronic detonation control circuit as claimed in any one of Claims 1 to 3, characterised in that the threshold value circuit has a voltage divider with a longitudinal resistance in the form of a Zener diode.
5. An electronic detonation control circuit as claimed in any one of Claims 1 to 4, characterised in that the switching member and the blocking section each have a transistor, and in that the transistors are mutually complementary transistors.
6. An electronic detonation control circuit as claimed in any one of Claims 1 to 5, characterised in that a safety voltage delay device is



connected, between the threshold value circuit and the logic circuit, to the power source.

7. An electronic detonation control circuit substantially as
5 hereinbefore described with reference to the accompanying drawing.

8. A munition incorporating the circuit claimed in any preceding claim.

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