

A SAFETY DEVICE FOR A SECONDARY-EXPLOSIVE DETONATOR

This invention concerns improvements in or relating to safety devices for munitions, for example, a safety mechanism for a secondary-explosive detonator for the combat charge of a submunition projectile that is to be delivered by means of a carrier, as is shown in the journal WEHRTECHNIK NO. 9/1985 page 81/top in its essential functional components.

The military safety regulations for fuzes (US-MIL-STD-1316C dated 15th February 1977 Section 4.3.3a or respectively NATO-STANAG 3525 AA dated 23rd January 1976 Section 5) allow the realisation of a safety device without mechanical detonation-chain interruption if the function of the detonator for the detonation or actuation of the combat charge is based on the use of insensitive explosive mixtures, so-called secondary explosives. Such a detonator can be initiated, for example, by the sudden discharge of a large electrical charge (such a capacitor stored charge) by way of, for example, a piezoelectric pressure transmitter (DE-PS 29 31 765) or an exploding electrical conductor (US-PS 4 421 030, Figure 2). In the case of such a safety devices it must, of course, be ensured that the transition from secured or safe state into the live state is only possible when two environmental criteria, which are independent of one another and which are crucial for orderly function of the munition, are afforded.

Known safety devices have several disadvantages such as electrical series circuits which are disadvantageous for rapid high energy electrical discharge, bulk, weight, complexity, early arming of the munition, and limitations due to the kinds of the criteria able to be sensed.

An object of the invention is to provide a safety device which is less complex but highly functionally effective, and which with respect to switch function and installation factors, is preferably more suitable for submunition projectiles.

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According to the present invention there is provided missile apparatus comprising a submunition carrier and at least one ejectable submunition therein, wherein the submunition has a safety device comprising first and second sensor-controlled switches in series in a detonator circuit for a secondary-explosive detonator, wherein the submunition carrier has means to detect the presence of ambient-air incident flow on the submunition carrier and thereafter to provide an ejection command signal, wherein the first switch is energised or activated as a function of the submunition ejection command signal, and wherein the second switch is actuatable or activated by the first switch when said switches respond to the submunition projectile releasing itself from the carrier and deploying gliding wings employed in a target-seeking gliding-flight phase.

The present invention further provides a safety device of a submunition, for use in the apparatus, comprising first and second sensor-controlled switches in series in a detonator circuit, wherein the first switch is equipped with a first sensing member which is extendable to project from the safety device upon being energised or activated by way of a force store, which store is loadable from a force generator which is controlled in a time-delayed manner by an electrical device in response to inputting in to the safety device of a submunition ejection command signal issued after the presence of ambient-air incident flow upon a submunition carrier; wherein the second switch has a second sensing member which is angularly movable, in response to deployment of gliding wings of the munition; and wherein the second switch is actuatable or mechanically operable by the first switch after the first sensing member extends in response to release of the submunition projectile from the carrier and upon the second sensing member being freed to move angularly by deployment of the gliding wings.

During transition from the safe state into the live state, actuation of the first switch, initially triggered by the free-flight incident air flow upon the carrier, can be completed only as a result of the mechanical separation of the submunition projectile from its

packaging in the carrier; and actuation of the second switch, initiated as a result of operation of the first switch, can be actually carried out only when the ejected submunition projectile has achieved a given free-flight configuration.

5 An arming of or by the safety device is thus only possible if the carrier has achieved free-flight, and after that the submunition ejection has also led to the free-flight of the submunition projectile, whereby premature arming and faulty detonation are reliably avoided.

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For the free-flight detection of the carrier, recourse can be had to a conventional nose fuze with fluid generator (see for example US Patent 4 421 030). The release of the submunition projectile from the projectile package in the carrier and the transition into the
15 submunition free-flight phase can be detected most reliably and constructionally most simply by mechanical sensing of carrier construction elements, in the neighbourhood of the submunition installation, and of gliding-wing construction elements which, upon the swinging-out of the submunition gliding wings, release a lock.

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Preferably a mechanical transmission coupling between the function of the two switches is provided, in such a way that both switches can be transferred into the closed electrical state, or conductive ON-position only when all the function criteria for the
25 transition from the safe state into the live state are fulfilled, in other words when after the free-flight of the carrier the ejection of the submunition projectile and the gliding-wing deployment have ensued. For this, functionally a or the force store is inserted between the first switch and a or the force device (controlled from
30 the carrier to provide power for actuation of the first switch); and a connecting link or slotted link force coupling is provided between the two switches, so that the switches mutually block each others transition into the respective ON-positions until all the criteria are fulfilled, whereupon the switch actuation can be performed by the
35 previously charged or loaded force store.

The apparatus and device of the invention provide very effective safety for secondary-explosive detonators; and the electrical, mechanical and electro-mechanical components of the device can be constructed to occupy only a very small space, such as an axially short and radially narrow segment of the submunition. In this respect
5 the switches can be so designed, for example by way of the arrangement of movable mechanical parts of, and associated with, the switches,

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that the acceleration forces upon the launching of the carrier and upon the ejection of the submunition do not cause any functionally critical switch stressing. More especially one of the switches preferably has a switching member, orientated in the cross-section of the submunition along a chord, with a sensing member which extends through the casing of the submunition and which by way of an entrainment means engages into a swingable switch member of the other switch, which switch member is arranged to swing in a direction generally parallel to the longitudinal axis of the submunition; and in which respect said other switch preferably engages in axially-parallel manner through the disc-segment-shaped structure of the safety mechanism, in order by way of the displacement of a blocking element to sense the completed swing-out of the gliding wings of the submunition and thus the transition into the target-seeking phase, whereupon only with charging of a detonation condenser is the arming effected.

Alternative and further features and advantages of the invention are disclosed hereinafter in the claims, abstract and following description of a preferred example of the invention which is partially shown diagrammatically in the accompanying drawings which are simplified and not to scale.

In the drawings:-

FIGURE 1 shows in broken-away and partially cut-open representation apparatus of the invention comprising a carrier and a submunition projectile;

FIGURE 2 is a block wiring diagram showing a series connection of first and second switches in a safety device of the invention for the submunition;

FIGURE 3 shows the incorporation of the safety device and ignition means in accordance with FIGURE 2 into the submunition, in partial cross-sectional representation of the submunition;

FIGURE 4 shows a second switch, standing in mechanical effective connection with a first switch, in a cross-sectional partial representation transverse to the representation of the safety device

in FIGURE 3; and

FIGURE 5 is a view similar to part of FIGURE 3 showing parts of a further-developed form of switch arrangement for the safety device.

5 An end-phase-steered or terminally guided submunition projectile 10 is equipped with an electro-mechanical safety device 11 for an electrically initiatable secondary-explosive detonator 12, which is connectable by way of an electrical ignition control 13, together with parallel-connected ignition condenser 53, in series with the series
10 connection of two sensor-controlled electro-mechanical switches 14.2 - 14.1 to an electrical energy store 15 (FIGURE 2). The store 15 can be a primary or of a secondary battery, or can be as shown, an electro-physical store 15 which is charged up at a given time from an external energy source. Depending on its capacity or output, the store 15 can
15 also, as shown, serve to supply further electrical power consuming devices, if independent stores are not provided for such devices.

The carrier 16 for the submunition projectiles 10 is equipped with a generator nose fuze 17 which, after the rocket launching or
20 respectively projectile firing of the carrier 16, is operated by the ambient-air incident flow 18 and supplies electrical power to the charge store (for instance a condenser or a secondary battery) of a central control circuit 19. After a specific flying distance there is effected, in a programme-controlled, separately-controlled or sensor-
25 controlled manner, the ejection of the submunition projectiles 10 radially out of the casing 20 of the carrier 16, so that these submunition projectiles 10 then - controlled by way of their seeker heads 21 - home-in on individual targets.

30 Shortly before the control circuit 19 initiates the ejection of the submunition projectiles 10, by way of a tear-off cable connection 22 there is effected a charge-transfer of electrical energy into the individual submunition energy stores 15 of the respective ignition circuit 23 in the safety devices 11.

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Moreover, by an ejection command signal 24' to the submunition

projectiles 10, by way of a trigger lead 24 of the cable connection 22, a time circuit 25 is initiated which, after expiry of a predetermined delay time t (and thus in the case of undisturbed function cycles with respect to the ejection of the submunition projectiles 10 after the departure of the submunition from the carrier casing 20) actuates a switching element 26 for supplying current to an electrically ignitable pyroelectrical force producing device 27 from the energy store 15, by way of feed leads 28 (FIGURE 2).

The ignition of the force element 27 brings about, transversely to the submunition longitudinal axis 56, an axial displacement of a ram 29 for the movement of the switching pin member 30 out of the OFF-position (shown in FIGURE 3) into the ON-position of the first switch 14.1 in which the member 30 provides electrical switching bridging between contacts 32. In the exemplified embodiment shown in FIGURE 3, only an axially limited region of the switching pin 30 has an electrically conductive surface 31, which in the ON-position bridges the contacts 32.

Of course, if the switching ram 29 is rigidly connected by the pin 30 to a sensing pin member 34, the ram and pin 30 can be advanced fully into the ON-position only when the emergence of the sensing pin 34 from the casing is no longer blocked by a structural element 35 or casing 20 of the carrier 16, so that the first switch 14.1 can be closed for electrical conduction only if the submunition projectile 10 has actually released itself from its holder in the carrier 16.

Because the displacement of the switching pin 30 into the ON-position upon actuation of the force device 27 can still be transiently mechanically blocked (if for example functional disturbances have prevented, within the timespan t , release of the submunition projectiles 10), the force-element ram 29 preferably does not act directly on the switching pin, but, as shown, by way of a spring force store 36 which is only stressed or loaded upon mechanical blocking of the switching pin 30 by obstruction of its integral sensing pin 34. Thus, after triggering of the force element 27,

the stressed force store 36 ensures the displacement of the switching pin 30 into the ON-position when the blocking of the switching pin 30 is cancelled.

5 In the exemplified instance shown in FIGURE 3, additionally a mechanical force transmission pin member 37 is interposed in the operative connection between the force device 27 and the first switch 14.1, in order to be able to facilitate installation of the switch 14.1 and the electrically actuatable force device 27 not directly
10 adjacent, but at constructionally more suitable locations, which afford installation space for a blocking or retaining mechanism 38 between the force device 27 and the spring force store 36. The mechanism 38 holds the pin 37 and thus also the switching pin 30 in the unactivated rest or OFF-position so long as the force device 27
15 has not been initiated. The blocking mechanism 38 is arranged to act on the pin 37 after actuation of the ram, for holding the spring force store 36 in its stressed condition and its displaced position, and thus the switching pin 30 in its ON-position, after the actuation of the force store 27, if, for arbitrary reasons, the ram 29 is not arrested
20 in its thrust-out position. In the exemplified instance shown, the blocking mechanism 38 has at least one rolling body 39 which is spring biased to butt radially towards the surface of the transmission pin 37, so that, in the OFF-position (shown in FIGURE 3) the body 39 engages in a recess 40 and thereby retains the transmission pin 37 in
25 this position. The retaining force is overcome by the axial force applied by the ram 29 to the pin 37 so that a rearward end surface 41 of the recess thrusts back the rolling body 39. Thereafter further movement of the pin 37 allows the rolling body 39 to be forced, for example by a spring 42, behind the end 41 of the transmission pin 37
30 to serve as a wedge, supporting the pin in its advanced position after the force of the ram 29 has abated.

To permit such radial movement of the rolling body 39 behind the end 41, the front end of the ram 29 may be tapered, but instead of or
35 in addition to such tapering, a taper, waist, recess or like narrowing can be formed at or adjacent the end of the transmission pin 37, or

the end 41 may protrude radially in a collar-shaped manner (not shown in the drawings) from the pin 37.

The switching pin 30 of the first switch 14.1 has a mechanical force transmission coupling 44 to a switching arm or member 43 of the second switch 14.2 lying electrically in series therewith. This force coupling 44 is, as shown in FIGURE 4, preferably realised by engagement of a switching-pin entrainment means 45 into a curvedly extending cam slot 46 in the switching arm 43 in such a way (see FIGURE 4) that, upon displacement of the switching pin 30 into the ON-position, also the switching arm 43 is moved about a swivel axis 47 into its ON-position. A part of said slot extends initially parallel to the movement of the switching pin 30, and thus of its entrainment means 45, so that the swivelling of the switching arm 43 is effected by the means 45 only after there has been a predetermined displacement of the switching pin 30, which predetermined displacement is possible only if the sensing pin 34 has emerged free of the blocking element 35. The second switch 14.2 is thus generally made operative or activated (so as to be able to close) only upon the first switch 14.1 moving into or only partially towards the ON-position when the conditions necessary for operation of the first switch, namely all the mechanical and electrical pre-requisites with respect to the separation of the submunition projectile 10 from the carrier 16, are fulfilled.

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However, the angular switching arm 43 is equipped with a sensing limb member 49 which is urged against a blocking element by the means 45 after stressing of the store 36 and which makes possible the displacement into the ON-position of the second switch 14.2 only if the blocking element 50, provided adjacent to safety mechanism 11 within the submunition 10, is swivelled from a blocking position (shown in broken lines) into a release position in which it is shown in FIGURE 4.

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This blocking element 50 is preferably a constructional constituent part of gliding wings which are hinged, so as to be able

to be swung out, to the casing 33 of the submunition missile 10, or a component part in operative connection with the wings. Since the swinging-out of the gliding wings 51 (FIGURE 1) is effected only a certain timespan after ejection of the submunition projectile 10 from its carrier 16 and after a subsequent stabilisation free-flight phase (initiated by a cycle control circuit, not taken into account in the drawing, on board the projectile 10), in other words when wings deployment movements are also no longer hindered by the submunition packaging in the carrier 16, the release of the sensing member 49 for transfer into an ON-position is effected only when the submunition projectile 10 is not only separated with certainty from the carrier 16, but moreover has deployed its gliding-flight wings 51. Up to then the switching arm 43 is blocked by the element 50 in its OFF-position; and by reason of the forced guidance of the switching-pin entrainment means 45 in the curvedly extending cam slot 46, the switching pin 30 can be displaced partially but not fully, into its ON-position despite release of the sensing pin 34. Thus, by way of the force coupling 44, a mutual mechanical inter-locking of both switches 14.1 - 14.2 is afforded, which can pass into their ON-positions only if the force device 27 has triggered (because the carrier 16 has been launched) and if the submunition projectile 10 has not only released itself completely from its stowage in the carrier 16, but has moreover with deployed its wings 51 and changed into the target-acquisition gliding flight phase. The safety criterion, of the two environmental factors which are independent of one another and which have to be fulfilled for the arming of the safety device 11, is thus guaranteed.

This arming is now effected if both switches 14.1-14.2 of the series connected are closed, by charge-transfer of at least a part of the electrical energy, which has remained in the energy store 15 after ignition of the force device 27, by way of a back-charging barrier such as a blocking diode 52, into the ignition condenser 53 which, to avoid unintentional static chargings, is bridged by a high-resistance parallel bleeder resistor 54. If a target object that is to be attacked has been detected by the submunition seeker head 21, and homed-in on, a detector (for example a proximity or an impact sensor)

supplies an ignition command 55 to the electrical ignition control 13, for example a spark gap or an ionisation breakdown device, so that the electrical energy stored (in the armed position of the safety mechanism 11) in the ignition condenser 53 is discharged suddenly by way of the secondary-explosive detonator 12, in order to fire the combat charge (not shown in the drawing).

The modification, shown in FIGURE 5, of the mechanism for actuation of the first switch (14.1) from the force device 27 has, as compared with the generally similar function of the switch actuation mechanism shown in FIGURE 3, the advantage of considerably greater shock resistance against radial and rotational accelerations of the submunition projectile 10, particularly accelerations in the direction of the longitudinal axis of the switching pin 30. This is because, in the modification shown in FIGURE 5, whilst an acceleration force component in the longitudinal direction of the switching pin 30 can temporarily lead to the fact that the transmission pin 37 is temporarily displaced somewhat against the restoring force of the spring store 36, the actual switching pin 30 is still not moved forward thereby, because it is still secured by the rolling bodies 39 in the safety device 11. This locking is released only when a severe displacement force, existing for a fairly long time, acts on the transmission pin 37 for the tensioning of the spring-force store 36, as occurs in practice only by the advance of the ram 29 out of the force element 27. If, then, the reduced or stepped rearward end 41 of the transmission pin 37 has been moved to or past the rolling bodies 39, the rolling bodies 39 (which normally butt against the pin surface 58 and extend through the wall, of a rearward hollow-cylindrical sleeve 59 around the switching pin 30, and extend into notches 60 in the surrounding safety device 11) are freed to move towards the interior of the sleeve 59.

Only when the rolling bodies 39 are then no longer forced by abutment with the surface 58 into the notches 60 can the force of the store 36 and the ram thrust raise the sleeve 59 together with the switching pin 30 and the entrainment means 45. For the securing in

the raised position, in which the sensing member 34 projects from the casing and in which the first switch 14.1 is closed to make an electrical connection, in the diagrammatic representation in FIGURE 5 a blade spring 61 is provided which is secured on the safety device 11 5 and after adequate displacement of the switching pin 30 engages into a recess 62. A reverse bias spring may act on the sleeve 59.

CLAIMS

1. Missile apparatus comprising a submunition carrier and at least one ejectable submunition therein, wherein the submunition has a safety device comprising first and second sensor-controlled switches
5 in series in a detonator circuit for a secondary-explosive detonator, wherein the submunition carrier has means to detect the presence of ambient-air incident flow on the submunition carrier and thereafter to provide an ejection command signal, wherein the first switch is energised or activated as a function of the submunition ejection
10 command signal, and wherein the second switch is actuatable or activated by the first switch when said switches respond to the submunition projectile releasing itself from the carrier and deploying gliding wings employed in a target-seeking gliding-flight phase.
- 15 2. Apparatus as claimed in Claim 1, wherein the first switch is equipped with a sensing member which is arranged to extend through a casing of the submunition and is actuatable by way of a force store which is loadable from a force device responsive, in a time-delayed manner, to the ejection command signal.
- 20 3. Apparatus as claimed in Claim 2, wherein part of the casing has a circular cross-section, and wherein the sensing member of the first switch is longitudinally displaceable along the line of a chord through said cross-section.
- 25 4. Apparatus as claimed in Claim 1, 2 or 3 wherein the second switch is equipped with a sensing member for sensing the position, dependent upon the position of the gliding wings, of a blocking element.
- 30 5. Apparatus as claimed in any one of the preceding claims, wherein a force transmissive coupling is provided between the two switches.
6. Apparatus as claimed in any one of the preceding claims, wherein the submunition has a longitudinal axis, and wherein the actuation of
35 the second switch is based on a swivel motion of a switching member



which extends generally parallel to the submunition longitudinal axis.

7. Apparatus as claimed in Claim 6 as appended to Claim 5, wherein the force transmissive coupling comprises an entrainment member which is provided on a switching member of the first switch, and engages
5 into a curved entrainment slot in the switching member of the second switch.

8. Apparatus as claimed in Claim 1, wherein a transmission member is provided between a force device and a force store for displacement of
10 a switching member of the first switch, wherein the transmission member is displaceable with the switching member and the force store by the force device and wherein a return movement blocking mechanism acts on the transmission member.

9. Apparatus as claimed in Claim 1 wherein arranged in the interior of a sleeve behind the sensing member of the first switch, is a spring-force store which is loadable from a force device by way of a transmission pin; and wherein rolling bodies extend through the walling of a sleeve, which extends around the pin, which bodies engage
20 both in notches formed in the device outside the sleeve and against the surface of the transmission pin prior to movement of the transmission pin by the force generator, and which move to prevent a return movement of the transmission pin after it has been displaced by the force generator.

25 10. Missile apparatus substantially as hereinbefore described with reference to FIGURES 1 to 4 or FIGURES 1, 2, 4 and 5 of the accompanying drawings.

30 11. A safety device of a sub-munition projectile, for use in apparatus as claimed in any preceding claim, comprising first and second sensor-controlled switches in series in a detonator circuit, wherein the first switch is equipped with a first sensing member which is extendable to project from the safety device upon being energised
35 or activated by way of a force store, which store is loadable from a



force generator which is controlled in a time-delayed manner by an electrical device in response to inputting in to the safety device of a submunition ejection command signal issued after the presence of ambient-air incident flow upon a submunition carrier; wherein the second switch has a second sensing member which is angularly movable,
5 in response to deployment of gliding wings of the munition; and wherein the second switch is actuable or mechanically operable by the first switch after the first sensing member extends in response to release of the submunition projectile from the carrier and upon the second sensing member being freed to move angularly by deployment of
10 the gliding wings.

12. A safety device as claimed in Claim 11, wherein the first switch comprises a switch member which is longitudinally displaceable by or with the first sensing member.

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13. A safety device as claimed in Claim 12, wherein the second sensing member is part of a switching member which extends generally parallel to the longitudinally displaceable switch member.

20 14. A safety device as claimed in any one of Claims 11 to 13 characterised in that a force transmissive coupling is provided between the two switches.

16. A safety device as claimed in Claim 13, wherein entrainment means
25 is provided on the switch member of the first switch and engages into a curved cam slot in the switching member of the second switch.

16. A safety device as claimed in any one of Claims 11 to 13, wherein provided between the force generator and the force store for the
30 displacement of the sensing member of the first switch is a transmission member displaceable with the sensing member and the force store by the force element, and wherein the transmission member is acted upon by a return blocking mechanism.

35 17. A safety device as claimed in any one of Claims 11 to 16, wherein



the force store comprises a spring arranged in the interior of a sleeve, behind the sensing member of the first switch, which spring is stressable by the force generator by way of a transmission pin, and wherein rolling bodies extend through walling of a sleeve, which extends around the pin and store, and engage both in indents formed in
5 the device outside the sleeve and against the surface of the transmission pin prior to actuation of the force generator.

18. A safety device substantially as hereinbefore described with reference to FIGURE 2, or FIGURES 3 and 4, or FIGURES 4 and 5, or
10 FIGURES 2 to 4 or FIGURES 2, 4 and 5 of the accompanying drawings.

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