

19

DESCRIPTION

The invention relates to a reversible safety device in accordance with the definition of the species of claim 1.

A safety device in accordance with the species is known from AT-B-362 280 for land mines. In order to be able to arm the mine in a remote-controlled manner, there provision is made for accommodating its detonation pellet in a rotor, which experiences a rotary drive by way of a manually windable spring when a mechanical rotary-movement lock is temporarily cancelled by means of an electrically controlled magnet. The rotor then carries out, under the influence of the torque of the spring, a limited rotary movement, until the pellet is in its effective position. If the spring is designed still to have a residual bias in this armed position, then the electromagnet can be controlled afresh, in order to cancel temporarily the actual locking and to allow the rotor to rotate into its ineffective position again. The mine de-armed by the residual tension of the spring can then be secured manually in this rotor position, in order where applicable to be able to wind the spring afresh for a renewed use.

On account of the requirement of a complete spring mechanism for the stop locking and for the rotary movement of the detonation-pellet rotor, this safety device is indeed constructionally really complex and operationally critical, particularly in view of the torque requirement for the movement of the wheel-work even still upon the action of the environment after a fairly long depot or field storage.

In addition to this, it is operationally disadvantageous that basically it cannot be precluded that the release of the rotor locking is not effected only by the remote control of the electromagnet, but already as a result of shock stresses, as cannot be avoided upon the laying of the mine or upon the detonation of adjacently laid mines. Thus, it can lead to an unintended rotary movement into the armed position, without this being noticeable to the mine engineer at his remote-control device; with the result that on the other hand a supposed de-arming by reason of preceding unintentional release of the rotor movement now actually leads to an armed position and endangers the mine engineer who wishes to tension the driving spring manually afresh. The same exposure to danger can result from the fact that on the part of the electrical release remote control it is not perceivable how great the residual energy stored in the spring is. Particularly under combat conditions, therefore, it can erroneously be assumed that the existing residual energy is still adequate for a de-arming rotary movement, without this, however, in actual fact being sufficient for the further rotation of the detonation-pellet rotor into the safe position. The mine engineer, who has actuated the electromagnetic remote control for the re-securing, can thus in no way be sure that, despite prescribed response of the electromagnet; a transition into the re-secured (de-armed)

50

position has been accomplished. For reasons of caution a renewed manual tensioning of the driving spring is now no longer a possibility, and the mine must, without sure knowledge about its arming state, be left lying in the ground.

A safety device similar to the species is known from DE-A-3 025 230. In the fuze safety chain serving there as second arming criterion is the occurrence of the output signal of a time switching circuit which has been started up with the laying of the mine by the safety device having been transferred manually into a preparation position. After expiry of the thereby predetermined safety time interval, the retaining force of a permanent magnet is so severely weakened by a briefly oppositely acting electromagnetic field that an armature drops and thereby the displacement of a detonator slider into the armed position can take place. However, in the case of such a safety device (as also in the case of similar safety devices in which at least one of the safety elements is afforded by an acceleration-dependent displacement of a bolt or by an electrically controllable pyrotechnical force element) it is not possible, partly for energy reasons, partly for constructional reasons, to cancel with remote-action means the once reached armed position again and to return the mine into the de-armed position - especially if from this a functional cycle for the arming is to be able to be started up afresh.

However, precisely in the case of mines it is, as is well known, desirable to be able to return the once achieved ARMED position if necessary into a SAFE position of its safety device (and after that where applicable to allow the customary arming procedure to take its course again); for example, for the operational check or for the merely regional ARMED position of a laid mine-field.

Arising from these realisations the problem underlying the invention is to develop further a reversible safety device of the type in accordance with the species to the effect that, with mechanical construction elements which are electrically controllable in an operationally reliable manner, a clear reversal out of the prepared state into the ARMED position as well as subsequently a clear transfer back into the SAFE position is made possible, which is then so clearly afforded that the mine engineer can carry out in a sufficiently non-imperilled manner the manual transfer into a new preparation position; out of which a renewed arming/re-securing cycle can then be initiated in a remote-controlled manner.

In accordance with the invention this problem is solved, in the case of a safety device in accordance with the species, in that it is designed in accordance with the characterising part of claim 1.

In accordance with this solution, both for the transition out of the SAFE position into the ARMED position as also in case of need for the return into the SAFE position, thermal

51

energy is used which, more especially by way of resistance heating, is electrically easily producible and dosable. It merely needs to be designed for triggering in each case an adjusting or respectively restoring device having a reversible, bistable (thus reversible between two stable positions) switching behaviour. These adjusting or respectively restoring devices are preferably spring elements, so that the dimensioning of the adjusting paths, thus of the production tolerances of the component parts of such an adjusting device, is non-critical. Basically thermal bimetals having a bistable or snap characteristic are usable as such adjusting or respectively restoring devices, which - for example constructed as bending springs - when a specific, material-dictated and constructionally predetermined temperature is exceeded (after initially a slow change in curvature) experience a sudden change in shape.

However, the use of springs which consist of material having a shape memory ability (memory alloys) is more advantageous; and which have a reversible behaviour in the sense that, after a typical material temperature is exceeded, practically suddenly and along with the release of considerable forces a transition is effected out of the instantaneous spring basic position into a different spring basic position and this transition can be cancelled again after cooling down through the action of an external force. With respect to materials which are suitable for this, reference is made, for example, to EP-A-86 011 or EP-A-86 013 and, with respect to the shape-change kinetics, to DE-U-79 00 875.

In the SAFE position, in preparation for the transition into the ARMED position, both memory springs acting in opposite directions on a detonator which is displaceable in line are (in accordance with their relative arrangement and direction of attack) e.g. with a deformed martensitic textural structure in a specific basic position. In response to an item of information, which can be fed in e.g. by a time switching member or in a remote-controlled manner, one of the springs is temporarily heated directly or indirectly, e.g. electrically, until the transformation point from martensitic to austenitic structure is exceeded; with the result that the spring practically suddenly and along with considerable exertion of force assumes its other basic position, predetermined in production technology respects, having an austenitic structure and, in so doing, displaces the detonator into its ARMED position. For the return of the detonator into its SAFE position, the other martensitic spring, oppositely acting and still deformed, is briefly heated, until this assumes its predetermined second (austenitic) basic position, thus pushes the detonator out of the position of readiness to detonate again. At the same time the first-mentioned spring (which has in the meantime cooled down again to martensitic structure) is deformed by the more strongly designed force of the second spring back into the original basic position (which corresponded to the SAFE position of the detonator). Depending on the

22

constructional factors, the sequence of the structure transformations can, however, also be predetermined conversely.

In energy respects it is favourable, and it represents a particularly advantageous safety aspect, to undertake the deformation of the second-mentioned spring (which, by reason of its greater spring stiffness, in the transformed geometry prevents a displacement of the detonator into its ARMED position even upon premature, thus unintentional renewed heating of the first spring) after its cooling back into the martensitic structural state not by e.g. an electrically controllable incorporated force element, but through a force to be introduced externally - more especially manually. For this an auxiliary tool, for instance in the form of a plunger, can be provided, which makes it possible (without displacement of the made-SAFE detonator) to act upon the second spring, which has in the meantime cooled down, mechanically in such a way that it is restored into the geometry of its original basic position which no longer counteracts the first spring, accordingly thus no longer opposes a renewed displacement of the detonator into the ARMED position. In this respect provision can be made for starting up, with this return of the second spring into the initial position, the already mentioned time switching member, after the course of which the first spring then again heats up, thus the safety device is again set to ARMED.

Additional alternatives and further developments as well as further features and advantages of the invention will become apparent from the further claims and from the following description of a preferred example of realisation with regard to the solution in accordance with the invention which is shown in a highly abstracted manner in the drawings along with a restriction to that which is essential.

Fig. 1 shows the safety device in its SAFE position, prepared for control for the transition into the ARMED position,

Fig. 2 shows the safety device in accordance with Fig. 1 after transition into its ARMED position and

Fig. 3 shows the safety device after its remote-controlled restoration out of the ARMED position in accordance with Fig. 2 into the SAFE position of its detonator in accordance with Fig. 1.

Inserted into a cavity 1 of a land mine 2, as is used for example against armoured vehicles, is a safety device 3, which is shown in Fig. 1 in axial longitudinal section in the SAFE position of its detonator 4. In the interests of low production and assembly expenditure, the safety device 3 is composed substantially of axially-symmetrical, more especially cylindrical, components. Counting thereunder are here a hollow-cylindrical sleeve 5 with a screwed-in base 6 and a screwed-on lid 7 - also serving for the screwing in the mine cavity 1. The detonator 4 is arranged in the wall

of a cylindrical slider 8, so that in the SAFE position of the slider 8 it stands offset relative to a booster charge 9 which is arranged in the wall of the mine cavity 1 and represents a pyrotechnical activation connection to a combat charge (not shown in the drawings) of the mine. In the drawings it is, furthermore, not taken into account that as a rule also additionally constructional measures are provided which lead to the safe burn-off of the detonator 4 if for some reason it should have triggered in its SAFE position. An axial pin 10 which is held on the base 6 and which engages into an axial bore 11 (extending offset relative to the arrangement of the detonator 4) serves equally as an additional longitudinal guide indirectly for the movement of the slider 8 in the sleeve 5 and directly for a supporting spring 12 which is supported contrary to to the slider 8 and which engages, for example, into the bore 11; as also (in conjunction with the base 13 of the blind-hole bore 11) as a stop 14 for the displacement of the detonator slider 3 into the ARMED position (Fig. 2), in which the detonator 4 stands in line with the booster charge 9, thus the combat charge of the mine 2 can be detonated.

For this transfer of the detonator slider 8 out of the SAFE position in accordance with Fig. 1 into the ARMED position in accordance with Fig. 2, an adjusting device 15 is activated from an electrical armer 16 which is activatable, for example, by way of a time adjusting member 17 and/or a cable- or radio control 18 after the laying of the mine 2 and supplies the energy for the action of a reversibly-working, thermally-triggerable adjusting device 15 which has bistable behaviour. Such an adjusting device 15 is preferably a spring - here in the sense of the most axially-symmetrical structure possible of the safety device 3 a spiral compression spring 20 made of so-called shape memory material (memory alloy) which is supported against the lid 7 and which acts, directed contrary to the supporting spring 12, e.g. by way of an abutment ring 19 on the detonator slide 3. This is, in the depicted preferred example of realisation, so adjusted that, after material heating above a structure-technologically predetermined critical temperature, it endeavours to assume, practically suddenly and along with the release of a great force, its axially expanded position, thus presses elastically against the abutment ring 19 and thereby displaces the slider 3 into the ARMED position of the detonator 4, against the pin stop 14 and contrary to the action of the supporting spring 12. The fact that the transforming of the geometry of the compression spring 20 can be effected only when, and not until, a first safety criterion 21 (for example a mechanical or electrical locking directly on the detonator slider 3 or linked with the control possibility of the armer 16) has been triggered, is taken into consideration only globally in the drawings. The temperature rise which is necessary for the change in shape of the compression spring 20 can be brought about by direct injection of a heating current or by operation of a separate heating element from the armer 16; in the same way as the actuation of a breaker switch 39 for this heating device 40 by reason of displacement of the detonator slider 8 into its

24

ARMED position, as is taken into account globally in the drawings.

In order to be able to displace the detonator slider 8 in a remote-controlled manner back again into the SAFE position (Fig. 3) (before the mine 2 has been caused to respond by way of the ignition of the detonator 4), there acts contrary to the adjusting device 15 in the form of the shape memory compression spring 20 a corresponding restoring device 22 having a shape-memory reaction-pressure spring 23; which (triggered e.g. again from a time switching member 17', or by way of a remote control 24) is operable from an electrically controllable restoring device 25 in an appropriate manner, as explained above for the shape-memory compression spring 20. The shape-memory transformation force and the spring constant of the compression spring 23 are so designed that the restoring device 22 (supported by the identically directed action of the supporting spring 12) can displace the detonator slider 8 contrary to the pressing force of the adjusting device 15 back into the SAFE position and in so doing can deform the shape-memory compression spring 20, which has in the meantime cooled down, into its other stable, the axially short initial position (Fig. 3), in which thus the detonator 4 no longer lies in line with the booster charge 9 and the first safety criterion 21 is effective again.

In order to re-establish the full operational readiness of the safety device 3 in accordance with Fig. 1, thus with the possibility of a complete arming/restoring cycle of its safety device 3, the shape-memory reaction-pressure spring 23 has to be returned, after its cooling down, into the compressed geometrical shape again. For this a manual auxiliary tool in the form of a restoring plunger 26 is provided, with which the reaction-pressure spring 23 can be compressed again. On account of the greater restoring force, compared with the arming force of the adjusting device 15, the mine 2 remains reliably safe, so long as the corresponding manual operation by means of such a preparing plunger 26 has not been carried out - thus the reaction-pressure spring 23 has not been lifted off again from the detonator slider 3, but still presses fully against the slider 8. In order to make the restoration possible, and in order in this respect to prevent an unintentional displacement of the detonator slider 8 into the ARMED position, the reaction-pressure spring 23 butts only indirectly against the slider 8, namely by way of a reaction-pressure ring 27. This can be raised by means of a sliding sleeve 28 situated between the outer sleeve 5 and the slider 8 (along with compression of the reaction-pressure spring 23) from the detonator slider 8; by the plunger 26 being pressed vis-a-vis the reaction-pressure spring 27 against a sliding-sleeve traverse 29 which extends through an axially-parallel diagonal slot 30 in the slider 8. In this way the sliding sleeve 28 can also be displaced relative to the slider 8, which remains held by the supporting spring 12 in this respect in its instantaneous position, stationarily relative to the outer sleeve 5; namely butting against the

compressed compression spring 20, which now acts only with negligible residual force.

Advantageously, as taken into account in the drawings, for the insertion of the plunger 26 there is fastened in the sleeve lid 7 a guidance sleeve 31 which extends into a blind-hole bore 22 of the slider 8 and can also serve for the guidance of the spring 20. In the same way that the slider 8 has slots, also the sleeve 31 is slotted for the passage of the sliding-sleeve traverse 29.

Likewise in the interests of low-friction longitudinal guidance provision can be made (as taken into consideration in the drawings) for profiling the slider 8 convexly in the frontal region 33 - for example as a protruding frustum - in order by engagement into a geometrically adapted concave recess 34 on the opposite reverse side of the reaction-pressure ring 27 to produce at the same time an axial mutual guidance additionally for the axial-guidance effect of the supporting spring 12 surrounding the pin 10, without having to lengthen the overall length of the slider 3 for such an effect.

The detonator slider 8 does not (in accordance with the exemplified embodiment discussed above) have to be designed and arranged so as to be axially displaceable; also a swivel movement between the SAFE position and the ARMED position of the detonator 4 relative to the booster charge 9 arranged in an apparatus-fast manner is a possibility. However, simpler kinematic conditions and dimensioning possibilities more especially for the shape-memory springs 20 and 23 arise with rectilinear spring paths and with memory shape changes with reciprocally directed rectilinear application by way of the slider 8. Of course, the springs 12, 20, 23 do not have to be designed as compression springs, they can equally also act as tension springs for the displacement of the detonator 4 on its slider 8, taking into account appropriately amended application factors of the manually actuatable preparation plunger 26.

In the drawings it is symbolically taken into consideration, after manipulation by means of this plunger 26, to allow the detonator slider 8 to transfer automatically into the ARMED position. For this purpose, provided in the simplified representation is a contact 35 which upon displacement of the reaction-pressure ring 27 by means of the plunger 26 into the preparation position (in accordance with Fig. 1) by way of an electrical trigger stage 36 starts up the time switching member 17. This is so adjusted that after an adequate safety time interval as from inspection of a mine field - namely as from the preparation position achieved manually by means of the plunger 26 - the respective adjusting device 15 is again controlled and thereby the detonator 4 is again transferred into the armed position; so that then upon triggering of the mine sensor 37 by way of an ignition element 38 the detonator 4 can be ignited.



26

PATENT CLAIMS

1. A reversible safety device (3), more especially for a mine (2), with a detonator (4), which is transferrable from a SAFE position into its ARMED position and is if necessary also returnable again into the SAFE position, characterised in that a thermally-triggering restoring device (22) reversible between two stable positions, for the return of the detonator (4) into its SAFE position, and, switching oppositely thereto, a thermally-triggering adjusting device (15) reversible between two stable positions, for the transfer of the made-SAFE detonator (4) into its ARMED position, act on the detonator (4).
2. A safety device according to claim 1, characterised in that the restoring device (22) also serves for the transfer back of the adjusting device (15) into its initial position, in the SAFE position of the detonator (4).
3. A safety device according to claim 1 or 2, characterised in that the restoring device (22) is returnable into its initial position by an externally-acting auxiliary device (plunger 26).
4. An adjusting device according to claim 3, characterised in that the auxiliary device is a manually movable plunger (26) which is insertable from the outside into the safety device (3).
5. A safety device according to claim 3 or 4, characterised in that the auxiliary device cooperates with a time switching member (17) for the onset of the control of the adjusting device (15).
6. A safety device according to one of the preceding claims, characterised in that a supporting spring (12) acts on the detonator (4) in the same direction as the restoring spring (22), thus contrary to the effect of the adjusting device (15).
7. A safety device according to one of the preceding claims, characterised in that the restoring device (22) and the adjusting device (15) are designed as spiral springs (20, 23).
8. A safety device according to one of the preceding claims, characterised in that the restoring device (22) and the adjusting device (15) are arranged as compression springs (23, 20) coaxially and on both sides of a detonator slider (3) and are supported axially against the front ends of a housing sleeve (5).
9. A safety device according to claim 7, characterised in that arranged concentrically in the restoring device (22) is a pin (10) as guide for a supporting spring (12) and as stop (14) for the displacement of the slider (3) into the ARMED position of the detonator (4).

10. A safety device according to claim 8 or 9, characterised in that the detonator (4) is arranged in a slider (8) which butts rearwardly against the adjusting device (15) and butts frontally by way of a reaction-pressure ring (27) against the restoring device (22), in which respect, however, the reaction-pressure ring (27) can be lifted off axially from the slider front side (33) along with compression of the restoring device (22).

11. A safety device according to one of claims 8 to 10, characterised in that the detonator slider (3) is axially displaceable in a sliding sleeve (28) which butts frontally against the reaction-pressure ring (27) and against which rearwardly an external plunger (26) can be pressed.

12. A safety device according to one of the preceding claims, characterised in that heating devices (40) which can be switched off by the respectively triggered adjusting or respectively restoring device (15, 22) are provided.

13., A safety device according to one of the preceding claims, characterised in that the restoring device (22) and the adjusting device (15) are designed as springs (23, 20) made of a material having shape memory ability.

