

# PATENT SPECIFICATION

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## (54) AN IMPROVED FUSE FOR A SPINNING PROJECTILE

(71) We, WERKZEUGMASCHINENFABRIK OERLIKON-BUHRLE AG., a company organised and existing under the laws of Switzerland, of Birchstrasse 155, CH-8050 Zurich, Switzerland, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a new and improved construction of fuse for a spinning projectile of the type comprising an electromagnetic ignition current generator and a fuse chain for exploding an explosive charge of the spinning projectile, the ignition current generator incorporating a coil armature.

With a state of the art fuse of this type the fuse chain is arranged in axial direction after the ignition current generator. A drawback of this prior art construction resides in the fact that the fuse chain and the ignition current generator require a great deal of space, which then is no longer available for further fuse components or for the explosive charge.

Hence, it is an object of this invention to provide a new and improved construction of fuse for a spinning projectile which is not associated with the aforementioned drawbacks and limitations of the prior art proposals.

The present invention provides a fuse for a spin-stabilised projectile comprising an electromagnetic generator and an igniting train for an igniting current to initiate an explosive charge in the projectile, said generator having an annular field magnet and a wound armature which are relatively rotatable, and in which a detonator cap in the igniting train has a flame emitting primer inside the wound armature at the same location as the field magnet.

Reference is now made to the accompanying drawings, wherein:—

Figure 1 is a fragmentary longitudinal sectional view through a projectile fuse or

fuse arrangement incorporating an electromagnetic ignition current generator and constructed according to a first exemplary embodiment of the invention;

Figure 2 is a cross sectional view taken substantially along the line II—II of Figure 1;

Figure 3 is a fragmentary sectional view, similar to the showing of Figure 1, of a second exemplary embodiment of the invention; and

Figure 4 is a cross sectional view taken substantially along the line IV—IV of Figure 3.

Describing now the drawings, it is to be understood that only enough of the projectile structure has been shown in order to enable those skilled in the art to readily understand the basic concepts of the invention. Turning attention to Figure 1 wherein there is illustrated a preferred constructional embodiment of fuse for a spinning projectile it will be seen that such fuse embodies a fuse housing 1 consisting of a front housing portion 2 and a rear housing portion 3, these two housing portions 2 and 3 being threadably interconnected with one another by means of the threaded screws or bolts 14, 16 or equivalent structures. The fuse of fuse arrangement of this development is located in a blindhole bore 4 at a tail or rear portion 5 of the projectile and bears against the base or bottom of such tail portion. This blindhole bore 4 is substantially concentrically arranged with respect to the lengthwise axis of the projectile, and which projectile is generally indicated by reference character 100. In a central bore 6 of the rear housing portion 3 there are arranged two fuse elements which have been shown in broken or phantom lines, namely a current storage 7 and an electronic control means 8. The housing portion 3 possesses a cover or cover member 9 with a forwardly protruding cylindrical projection 10 in which there is centred the front or forward housing portion 2. The front housing portion 2 possesses a groove 11 in the

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central plane of which there is located the fuse axis. Arranged in the groove 11 is a double-pole armature 12 (Figure 2) which incorporates a substantially hollow cylindrical central armature portion or part 13 having a floor or base 13a which bears upon a recess 9a in the housing cover 9 and which recess is located substantially concentrically with respect to the fuse axis. The front housing portion 2 bears under the pressure of screws 14 or the like against an end face of the armature portion 13, so that the armature 12 is force-lockingly connected with the fuse housing 1. Two arms or arm members 15 which extend outwardly from the central armature portion or part 13 bear upon the projection 10 of the rear housing portion 3. Two windings or coils 16 are arranged upon the arms 15. In a bore 13b in the armature portion 13 there is arranged a detonator cap 17, constituting part of a fuse chain of the fuse. The detonator cap 17 contained in a jacket or shell includes an electrically ignitable flame-emitting primer 17'. A contact pin 18 of the detonator cap 17 piercingly extends through a bore in the floor or base 13a of the armature portion 13 into a plug component or part 19 which is arranged in the bore 6 of the rear housing 3 and engages in a bore of the housing cover 9. The plug 19 is connected in not particularly illustrated manner with the current storage 7, which typically may be constituted by an electrical storage capacitor.

The front end face of the front housing portion 2 possesses a recess 20a in which there is rotatably mounted a rotor 20. The axis of the rotor 20 is disposed essentially parallel to the lengthwise axis of the projectile 100. The rotor 20 possesses an eccentric bore 21 in which there is arranged a detonator 22 forming a part of the fuse chain. In the so-called armed or live position of the rotor 20 the axis of the bore 21 coincides with the fuse axis. The charge of the detonator can be exploded by the flame action of the detonator 17. The groove 11 is in spatial connection through the agency of the bores 23, 24 in the housing 1 and in the rotor 20 with the bore 21 containing the detonator 22.

A cover member 25 closes the front end of the fuse housing 1. By means of a threaded disc or plate 102 or equivalent fastening expedient, and which disc 102 is threadably connected with a threaded part 4a of the bore 4 of the tail portion 5, it is possible to fixedly retain the fuse in the bore 4 of the tail or rear portion 5. A capsule or detonator 27 which contains a reinforcement charge, and which detonator 27 is concentrically arranged with respect to the fuse axis, forms the last element of the fuse chain of the fuse arrangement. The detonator 27 is secured in a bore 101 of the

threaded disc 102, this detonator extending forwardly into an explosive charge 28 which is arranged in a projectile body portion 29 also threadably connected with the tail portion 5.

An annular or ring-shaped double-pole field magnet 30 is arranged in an outer recess 31 of the fuse housing 1. This magnet 30 is fixedly connected with a first bearing race 32 of an axial ball bearing and bears via the ball members 33 upon a second bearing race 34. The balls or ball members 33 are not separated from one another by a cage, so that in order to obtain the requisite load supporting function of the bearing an appropriate large number of balls can be arranged. The supporting surface, by means of which the magnet 30 and the first bearing race 32 which is fixedly connected therewith bears against the balls 33, has been designated by reference character 39. The second bearing race 34 is seated against forwardly directed protruding or bulging portions 36 of a ring member 35, these bulging or protruding portions 36 being arranged at a uniform angular spacing from one another. The ring or ring member 35 in turn bears against a rear flank 37 of the annular groove or recess 31 which is directed perpendicular to the fuse axis. In the arrangement shown in Figure 1 the magnet 30 has been illustrated in the transport position in which it is held pressed by means of its end face at a forward or front flank 38 of the annular groove or recess 31 under the pressure of the pre-biased projections or bulging portions 36 of the ring member 35.

Having now had the benefit of the description of the first exemplary embodiment portrayed in Figures 1 and 2 its mode of operation will be considered and is as follows: By virtue of the fact that the field magnet 30 in the transport position is pressed against the front flank, it is prevented from rotating relative to the projectile prior to the firing thereof. When there appears the acceleration of the projectile upon the firing of such projectile then the bulging or protruding portions 36 of the ring member or ring 35 are compressed together under the action of the inertia force applied at the magnet 30. Consequently, magnet 30 is free, so that it does not experience any rotational drive through the action of the fuse housing 1 which now rotates with the projectile. The inner and outer jacket surfaces of the magnet 30 and the race 32 are equally free in that they possess a spacing both from the wall of the bore 4 as well as also from the base or bottom 31a of the annular or ring-shaped groove 31. Due to the fact that the magnet 30 is mounted at the balls, upon firing of the projectile, this magnet 30 under the action of the inertia force which is applied thereat automatically

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assumes a stable equilibrium position in which it is centered at the rear bearing race 34 and maintains such position upon passage of the projectile through the firing barrel of the weapon. In this position, the magnet 30 neither contacts the tail or rear portion 5 nor the fuse housing. Owing to its arrangement in the ring-shaped groove or recess 31 of the fuse housing 1, in other words at the largest possible diameter, this magnet 30 possesses a large moment of inertia. By virtue of this large moment of inertia of the magnet 30 and its mounting at a roller bearing, during the acceleration phase of the projectile in the weapon barrel there occurs a large relative rotational speed between the magnet 30 and the armature coil arrangement 12, 16.

Since the detonator cap 17 is arranged within the bore 13b in the armature portion or part 13 there is achieved a significant saving in space which can be advantageously employed for the arrangement of other fuse components or the explosive charge.

Considering now the second exemplary embodiment as shown in Figures 3 and 4 there will be recognised a fuse housing 1a which is threaded into a rear portion of a projectile body 29a and bears with its shoulder 42 at such projectile body. The fuse housing 1a possesses an eccentric bore arrangement 43, 44 with regard to the lengthwise axis of the projectile and which bore arrangement 43, 44 is stepped in diameter. In the narrow bore portion 43 there is rotatably mounted a rotor 20b. In the other bore portion 44 there is inserted a disc or plate 45 in which there is threaded a detonator or detonator cap 27' provided with a reinforcement charge 27a. The detonator cap 27' with the reinforcement charge 27a extends into an explosive charge 28a contained in the projectile body 29a. The reinforcement charge 27a is in spatial communication by means of a bore 46 with the bore portion 43. A detonator 22a is inserted into a continuous bore 21b of the rotor 20b, the spacing of the lengthwise axis of the detonator 22a from the rotor axis is equal to the spacing of the rotor axis from the projectile axis. At its rear end the fuse housing 1a possesses a bore arrangement 47, 48 which is stepped in diameter. The front bore portion 47 opens into the bore 43 contained in the rotor 20b and is separated by a shoulder 48a from the rear bore portion 48.

A base piece or element 49 of the projectile bears by means of a flange edge 50 at the fuse housing 1a and possesses a substantially sleeve-shaped projection 51 which extends into the bore 48 and threaded with the fuse housing 1a. Between the end face of the projection 51 and the shoulder 48a there is arranged a substantially ring-

shaped permanent magnet 30a. The base portion or piece 49 possesses a central blindhole bore 52. In this blindhole bore 52 there is arranged a ball 53 by means of which there is supported at the base portion 49 a substantially cup-shaped cage 55 by means of its pin or plug member 54. This cage 55 is provided at its forward edge with two diametrically oppositely situated cut-outs or recesses 55' in which there is secured a support or carrier 56, as best seen by referring to Figure 4. The support 56 is mounted by means of a sleeve-shaped projection 57 in the fuse housing 1a. The support 56 simultaneously forms the armature core at which there is wound off-centre a coil or winding 58. Diametrically opposite the coil 58 there is arranged at the support 56 a piezoelectric crystal 59 at the base of a bore 56' of the support 56 and which bore opens towards the rear end face of such support. In this bore 56' there is further arranged an insulating body 60 in which there is movably mounted an inertia body 61 and bears at the piezoelectric crystal 59. The support 56 possesses a bore 62 which is coaxially arranged with respect to the lengthwise axis of the projectile and in which bore there is inserted a detonator cap 17a having a conventional flame emitting primer 17'. The one pole of the electrical firing current circuit for the firing means, in this case the detonator cap 17a, is connected to the body of the support 56 and the other pole extends in the form of a contact pin 18a into a control element 63 which is mounted in an insulating element or piece 64. Furthermore, in the cage 55 there are arranged in not particularly illustrated manner a rectifier and a capacitor constituting an energy or current storage device, wherein the capacitor is connected via a here not particularly illustrated control circuit with the detonator cap 17a for controlling different operating conditions of the fuse.

Having now had the benefit of the foregoing description of the variant embodiment of projectile fuse for a spinning projectile as considered above with respect to Figures 3 and 4 there will be now discussed its mode of operation which is as follows: Prior to firing of the projectile the fuse chain or circuit consisting of the detonator cap 17a, the detonator 22a and the cap with the reinforcement charge 27a is interrupted in that the detonator 22a is located externally of the projectile axis. Upon firing of the projectile carrying the fuse the ball 53, owing to the load of the inertia force applied at the cage 55, slightly penetrates into the base piece or portion 49. As a result there is imparted to the cage 55 its freedom of movement, so that it can rotate relative to the projectile. During the passage of the projectile through the firing barrel of the

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weapon from which it is fired the projectile is accelerated to a very high rotational speed. Since at the plug or pin member 54 of the cage 55 a frictional force engages at only a very small lever arm, this cage experiences a correspondingly small rotational drive. The rotational speed of the cage 55 is therefore only very small owing to the large moment of inertia of its mass, so that the difference between the rotational speed of the rotary magnet 30a which rotates with the projectile and the cage 55 and which is important for the generation of the current is practically equal to the rotational speed of the projectile.

After the projectile has departed from the firing barrel the rotor 20b is rotated for the purpose of closing the fuse or firing chain 17a, 22a, 27a. The inertia body 61, upon impact of the projectile at the target, is braked by the piezoelectric crystal 59. The current which is generated due to loading of the piezoelectric crystal 59 by means of the inertia body 61 is used for controlling the ignition of the flame emitting primer 17' in the detonator cap 17a. By means of the detonator cap 17a there is initiated through the agency of the detonator 22a and the reinforcement charge 27a the detonation of the projectile explosive charge 28a.

By virtue of the fact that the support 56 is advantageously employed as the armature core, the length of the cage 55 can be maintained relatively small. Due to this saving of space in the axial direction the projectile can be provided with a greater quantity of explosive charge 28a.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims.

Attention is directed to our co-pending Patent Application 19565/75 (Serial No. 1485212) which describes and claims a projectile fuse for a spinning projectile, comprising a fuse housing, a detonator cap, an electromagnetic ignition current generator, said ignition current generator containing at least two generator components, one of the generator components being constituted by a permanent magnet fixedly supported at the fuse housing and the other generator component being constituted by a relatively rotatable armature coil, electrical elements for connecting the armature coil with the detonator cap, and a cage rotatably mounted relative to the fuse housing, the armature coil, the electrical elements and the detonator cap being arranged in the cage.

#### WHAT WE CLAIM IS:—

1. A fuze for a spin-stabilised projectile comprising an electromagnetic generator and an igniting train for an igniting current to initiate an explosive charge in the projectile, said generator having an annular field magnet and a wound armature which are relatively rotatable, and in which a detonator cap in the igniting train has a flame emitting primer inside the wound armature at the same location as the field magnet.

2. A fuse arrangement for a spinning projectile substantially as described herein with reference to Figures 1 and 2 of the accompanying drawings.

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Reference has been directed in pursuance of section 9, subsection (1) of the Patents Act 1949, to patent No. 1,354,249.

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