

PATENT SPECIFICATION

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(54) PROJECTILE FUSE FOR A SPINNING PROJECTILE CONTAINING A DETONATOR CAP AND AN ELECTROMAGNETIC FIRING OR IGNITION CURRENT GENERATOR

(71) We, WERKZEUGMASCHINEN-FABRIK 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 projectile fuse for a spinning or rifled projectile of the type containing a detonator cap and an electromagnetic ignition current generator which comprises a permanent magnet as a first component of the generator and an armature coil as the second component of the generator, wherein one generator component is fixedly mounted and the other generator component is rotatably mounted in the fuse housing, the armature coil being connected via electrical elements with the detonator cap.

According to a state-of-the-art projectile fuse of this type and permanent magnet is rotatably mounted as a generator component in the fuse housing. The armature coil or winding constituting the second generator component, the detonator cap and the electrical elements are fixedly assembled in the housing.

This prior art arrangement is associated with the drawback that for constructional reasons it is not possible to design the permanent magnet so large that its moment of inertia is sufficient to maintain its rotational speed small relative to the rotational speed of the projectile in order that because of a large difference between the rotational speed of the armature coil and field magnets there is produced electrical energy which is adequate for the ignition of an explosive charge.

It is possible according to the present invention to provide an improved

construction of projectile fuse for a spinning projectile containing a detonator cap and an electromagnetic ignition current generator which is not associated with the aforementioned drawbacks and limitations of the prior art proposals.

Accordingly the present invention provides 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.

By virtue of the fact that, apart from the armature coil, also the electrical elements, such as capacitor, switching plate, rectifier means and additionally the detonator cap are arranged in the rotatably mounted cage, the weight and therefore also the moment of inertia of the rotating generator component is appreciably increased.

The invention will be better understood when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:—

Figure 1 is a fragmentary longitudinal sectional view through a projectile fuse equipped with electromagnetic ignition or firing current generator and constructed according to a first exemplary embodiment of the invention;

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

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Figure 3 is a cross-sectional view of the arrangement of Figure 1, taken substantially along the line III—III thereof;

Figure 4 is a block circuit diagram of the fuse construction;

Figure 5 is a fragmentary longitudinal sectional view, corresponding to the showing of Figure 1, of a further exemplary embodiment of the invention; and

Figure 6 is a cross-sectional view of the arrangement of Figure 5, taken substantially along the line VI—VI thereof.

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 there is illustrated a fuse housing 1 which is threaded into the rear portion of a projectile body 2. Machined into the fuse housing 1 from the front end face thereof is a bore 4, 5 which is stepped in diameter and eccentrically arranged with respect to the lengthwise axis of the projectile, as best seen by referring to Figure 1. A rotor 3 is rotatably mounted on the narrower bore portion 4. Pressed into the front bore portion 5 is a disk 6. A reinforcement charge 7 is threaded from the end face of the fuse housing 1 into the disk or plate 6 so as to be coaxially disposed with respect to the lengthwise axis of the projectile. The reinforcement charge 7 protrudes into an explosive charge 8 which is contained in the projectile body 2. Furthermore, reinforcement charge 7 is in spatial communication with the bore portion 4 by means of a bore 9. A detonator 10 is inserted into a continuous bore 11 of rotor 3, and the spacing of the bore 11 from the central axis of the rotor is equal to the spacing of the rotor axis from the projectile axis. The fuse housing 1 furthermore exhibits a bore 12, 13 which is stepped in diameter and which is machined from the rear end face of such fuse housing. The front bore portion 12 opens into the bore 4. The bore portions 12, 13 are separated from one another by a shoulder 14.

A tail or rear body portion 15 is threadably connected with the fuse housing 1. The end face or surface of the tail body 15 bears against a shoulder 16 of the fuse housing 1 and also bears at the rear end face or surface 17 of the projectile body 2. The tail or rear body 15 possesses a blindhole bore 18 which is stepped in diameter. A substantially ring-shaped permanent magnet 19 possessing two salient poles which are situated diametrically opposite one another bears against a bore shoulder 20 of the tail body 15 and is secured in the bore 18. The front open portion of a substantially cup-shaped cage 21 has a larger diameter

than its rear portion. In the floor or base of the cage 21 there is secured a pin or plug 22. The pin 22 bears against a ball or spherical member 23 which is arranged in a blindhole bore 24 machined from the base of the bore 18 into the tail body 15. The cage 21 is provided at its front edge with two diametrically oppositely situated openings or cut-outs 25 (Figure 3) in which there is attached a carrier or support 26. The support 26 possesses at its front end face a circular projection 27 which terminates in a plug or journal 28. This plug or journal 28 protrudes into the bore 12 of the fuse housing 1 and serves to mount the cage 21 therein. Between the support 26 and the fuse housing 1 there is inserted a ring member or ring 29 formed of polytetrafluoroethylene. The mounting of the cage 21 is undertaken such that its support 26 in the rest condition is slightly pressed against the ring 29, so that it is secured against rotation.

The axis of a central, continuous bore 60 of the support 26, and which bore is stepped in diameter, substantially coincides with the lengthwise axis of the projectile. A detonator cap 30 having a flame-generating firing means is inserted in this bore 60. The one pole of the electrical ignition or firing current circuit for the firing means is connected with the mass of the support 26 and the other pole 31 extends into a plug element 32 which is mounted in an insulation element 33 arranged in the stepped bore 60.

A piezoelectric crystal 34 is located at the base of a bore 61 of the support 26 which is open behind the rear end surface or face of such support. An insulating body member 35 is arranged in this bore 61. An inertia body 36 is movably mounted in a bore 62 of the insulation body or insulator 35 and bears against the piezoelectric crystal 34. An essentially rectangular switching plate 37 is arranged in the cage 21 in such a manner that its lengthwise central axis is parallel to the projectile axis and possesses a certain spacing therefrom.

A coil or winding 38 is wound about an armature core 39 which is oriented substantially perpendicular to the lengthwise axis of the projectile, penetrates through the switching plate 37 and is connected with the cage 21. The components 38 and 39 will be hereinafter conveniently referred to as the armature arrangement. The radial central plane of permanent magnet 19 essentially coincides with the equally directed central plane of the armature arrangement 38, 39. According to the showing of Figure 4 there is provided for the purpose of rectification of the alternating-current generated by the electromagnetic generator 19, 38, 39 a rectifier or rectifier arrangement 40, and for

the storage of such current an electrical capacitor 41. This capacitor 41 is electrically connected with the detonator cap 30 through the agency of a control circuit 42 which controls different operating conditions of the fuse. The piezoelectric crystal 34 is connected to the control circuit 42. The rectifier 40 and the capacitor 41 are arranged in a not particularly illustrated manner in the cage 21 between the armature arrangement 38, 39 and the support 26.

Now since both the armature arrangement 38, 39 as well as the detonator cap 30 with the flame ignition means are arranged in the cage 21, it is possible to wire the fuse independently of a projectile which houses the fuse. This furthermore affords the advantage that the entire fuse including the current circuit across the detonator cap 30 can be checked externally of the projectile and removed from its explosive charge 8.

Having now had the benefit of the foregoing description of the embodiment of projectile fuse for a spinning projectile as considered above with respect to Figures 1 to 4 there will now be discussed the mode of operation. Prior to firing the projectile the fuse chain or circuit consisting of the detonator cap 30, the detonator 10 and the reinforcement charge 7 is interrupted in that the detonator 10 is located externally of the projectile axis. Upon firing of the projectile carrying the fuse the ball 23, owing to the load of the inertia force applied to the cage 21, slightly penetrates into the tail or rear body 15. Consequently, there is now imparted to the cage 21 its freedom of movement, so that it can carry out a rotation with respect to the projectile. During the passage of the projectile through the firing barrel of the weapon from which it is fired the projectile is accelerated to a very high rotational speed. Since at the plug 22 of the cage 21 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 21 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 permanent magnet 19 and the cage 21 which is important for generating the current is practically equal to the rotational speed of the projectile. When the projectile after leaving the firing barrel is decelerated due to the resistance of the air, then the cage 21 under the action of the inertia force which is applied thereat bears via the ring 29 at the fuse housing 1. Consequently, the cage 21 experiences a rotational acceleration which, however, owing to the fact that the capacitor 41 has already been charged, is no longer of importance.

After the projectile has departed from the

firing barrel then the rotor 3 is rotated for the purpose of closing the fuse circuit or chain 30, 10, 7. The inertia body 36, upon impact of the projectile at the target, is braked by the piezoelectric crystal 34. The current which is generated due to loading of the piezoelectric crystal 34 by means of the inertia body 36 is used for controlling the ignition of the flame ignition means in the detonator cap 30. By means of the detonator cap 30 there is initiated through the agency of the detonator 10 and the reinforcement charge 7 the detonation of the projectile explosive charge 8.

Continuing, there will now be considered the variant embodiment of the invention as the same has been shown in Figures 5 and 6. It is to be appreciated that for this variant embodiment the same components have been designated by the same reference characters, whereas components which differ in their configuration have been designated in Figures 5 and 6 with the same reference character but in addition thereto by the lower case letter "a", and finally, components not present in the construction of Figures 1 to 3 have been designated with a new reference character.

With the exemplary embodiment depicted in Figures 5 and 6 the fuse housing 1a, which contains the reinforcement charge cap 7 and the rotor 3, forms an extension of the projectile body 2. The fuse housing 1a which bears by means of a shoulder 43 at the projectile body 2 possesses a bore 44, 45 which is stepped in diameter towards the front and which opens into the bore 4. The base piece 46 of the projectile bears by means of a flange edge 47 at the fuse housing 1a. A sleeve-shaped projection 48 of the base or bottom piece 46 extends into the bore 44 of the fuse housing 1a and is threadably connected therewith. A substantially ring-shaped permanent magnet 19 is arranged between the end surface or face of the projection 48 and the bore shoulder 49. The cage 21a bears through the agency of a ball 23 at the base piece 46. A further difference which is present in this embodiment from the first exemplary embodiment previously discussed resides in the fact that the support 26a forms the armature core at which there is wound offset from the center the coil 38a which is situated diametrically opposite the piezoelectric crystal 34. The switching or wiring plate 37a is arranged between the support 26a and the floor or base of the cage 21a. The advantage of the second exemplary embodiment of this development resides in the fact that owing to the use of the support 26a as the armature core it is possible to reduced the length of the cage 21a with respect to that of the first exemplary

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embodiment. In this way the projectile can be provided with a greater quantity of explosive charge.

- 5 Attention is directed to our copending Patent Application No. 19564/75 (Serial No. 1,485,211) which describes and claims a fuze arrangement for a spinning 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.

WHAT WE CLAIM IS:—

- 20 1. A projectile fuse for a spinning projectile, comprising a fuse housing, a detonator cap, an electro-magnetic 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.
- 35 2. A projectile fuse according to claim 1, wherein said cage is provided with a support which forms an armature core of the armature coil.

3. A projectile fuse according to claim 2, wherein the support is provided with a bore receiving the detonator cap.

4. A projectile fuse according to claim 2, wherein said cage is provided with a second support receiving the detonator cap.

5. A projectile fuse according to any of the preceding claims, having a piezoelectric crystal arranged in the cage, an inertia body located behind the piezoelectric crystal with respect to the direction of flight of the projectile, said inertia body upon impact of the projectile exerting by virtue of its inertia a pressure upon the piezoelectric crystal for generating a control current for triggering the fuse.

6. A projectile fuse according to any of the preceding claims, wherein the permanent magnet annularly surrounds the rotatably mounted cage and is secured in the fuse housing of the projectile fuse.

7. A projectile fuse according to claim 6, wherein the fuse housing contains a reinforcement charge and a rotor equipped with a detonator, said rotor rotating in such a manner upon firing of the projectile that the detonator is located between the detonator cap and the reinforcement charge.

8. A projectile fuse for a spinning projectile substantially as described herein with reference to the accompanying drawings.

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WHAT WE CLAIM IS:—

1. A projectile fuze for a spinning projectile, comprising a fuze housing, a detonator cap, an electro-magnetic 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 fuze 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 fuze housing, the armature coil, the electrical elements and the detonator cap being arranged in the cage.
2. A projectile fuze according to claim 1, wherein said cage is provided with a support which forms an armature core of the armature coil.

3. A projectile fuze according to claim 2, wherein the support is provided with a bore receiving the detonator cap.

4. A projectile fuze according to claim 2, wherein said cage is provided with a second support receiving the detonator cap.

5. A projectile fuze according to any of the preceding claims, having a piezoelectric crystal arranged in the cage, an inertia body located behind the piezoelectric crystal with respect to the direction of flight of the projectile, said inertia body upon impact of the projectile exerting by virtue of its inertia a pressure upon the piezoelectric crystal for generating a control current for triggering the fuze.

6. A projectile fuze according to any of the preceding claims, wherein the permanent magnet annularly surrounds the rotatably mounted cage and is secured in the fuze housing of the projectile fuze.

7. A projectile fuze according to claim 6, wherein the fuze housing contains a reinforcement charge and a rotor equipped with a detonator, said rotor rotating in such a manner upon firing of the projectile that the detonator is located between the detonator cap and the reinforcement charge.

8. A projectile fuze for a spinning projectile substantially as described herein with reference to the accompanying drawings.

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