

The invention relates to a device for aerodynamically braking a body, this braking being applicable particularly to the separation of initially linked bodies, for example the rear portion and the front portion of a projectile or the separation of bodies or sub-munitions initially contained in the projectile.

The main application of this device may be effected on a projectile rotating on itself containing payloads which are set free by the separation of the front portion and the rear portion particularly held in contact by a pin system, by virtue of the action of propulsion gases situated at the front of the projectile; when the latter has taken place, the rear portion of the projectile tends to remain in the vicinity of the payload and thus risks becoming a nuisance during subsequent sequences: the possibility of striking the payload in front of it, etc. In order to avoid this phenomenon, it is necessary to increase the aerodynamic drag of the rear portion of the projectile.

A device producing braking of a rear portion initially fixed to a front portion of a rocket is described in the Patent US-A-4,648,321. This patent describes a device for separating the payload 16 of a rocket 10, from the drive section 12. This separation is produced by means of a special section 14. For the present invention, concern is more particularly for the aerodynamic braking device which this section comprises. This device consists of a deployable surface 50 housed in an internal portion 30 of the section. This surface 50 is capable of two positions, a first position when the section 14 is of one body with the rest of the rocket and a second position deployed radially towards the outside so as to form an air brake after separation.

The passage from one of these positions to the other is ensured by a spring which acts after explosive withdrawal of a holding lock.

The surface 50 has a shape such that in the first position its external surface contributes to the

continuity of the external surface of the assembled body of the rocket. For this purpose, this surface may be defined as a portion of surface generated by a generatrix parallel to the axis of the rocket. Such a device, due to its complexity, is necessarily expensive, and it is only justified in being used on expensive assemblies, for example rockets. In such assemblies, the operation of each portion must be verified by prior tests producing, if possible, the conditions of the flight. This concern is not of interest for projectiles which, by nature, are intended to be mass-manufactured.

The present invention, for its part, is essentially applicable to projectiles for which a compromise must be found between reliability and cost.

One of the objects of the invention is therefore to produce an economic device providing aerodynamic braking of a first body which it is desired to separate from a second body to which the first body was initially assembled in order to form an assembled body. Another object of the invention is to shape this device so that its bulk only counts for a minimum reduction of the volume available in the internal portion of the first and second assembled bodies so as not to decrease the volume of the payload.

The invention therefore relates to a device for braking an element of a projectile, having a longitudinal axis OO' and intended to be driven with a rotational movement, the projectile comprising a front portion and a rear portion each having a body, an assembly of the two bodies forming a body of the projectile, the external peripheral surface of the body of the projectile delimiting an internal portion and an external portion, the front and rear portions being able to be separated from one another, the rear portion comprising means of braking capable of two positions: a first position when the front and rear portions are assembled, and a second position when these portions are separated, the braking means consisting of surfaces which in the first position, are

lodged in the portion internal to the body of the projectile and which in the second position are at least partially deployed outside the body of the rear portion, characterised in that the surfaces consist of thin strips
5 made from a material capable of plastic deformation and secured by one of their ends to the periphery of the body of the rear portion, passage from the first to the second position being obtained after separation of the front portion and of the rear portion under the effect of
10 centrifugal forces.

The invention and its characteristics will be better understood from reading the description of a particular application example which follows, and from the figures which represent:

15 - Fig. 1, a transverse section of the rear portion of a projectile before the separation phase according to the invention

- Fig. 2, a transverse section of the rear portion of a projectile during the separation phase
20 according to the invention;

- Fig. 3, a transverse section of the rear portion of a projectile after the separation phase according to the invention;

- Fig. 4, a transverse section of the rear
25 portion of a projectile before the separation phase according to an embodiment other than that of the invention;

- Fig. 5, a transverse section of the rear portion of a projectile after the separation phase,
30 according to the device of Figure 4;

- Fig. 6, a transverse section of the rear portion of a projectile after the separation phase according to another embodiment;

- Fig. 7, a diagram of the deployment of the thin
35 strips according to the invention.

- Fig. 8, an application diagram of the device on a body according to the invention.

- Fig. 9, a system for holding sub-munitions inside a projectile, before and after jettisoning;

- Fig. 10, a diagram of a system for delaying the opening of the thin strips secured to a sub-munition
5 according to the invention.

Figure 1 represents a transverse section of the rear portion of a projectile before the separation phase. This projectile is fitted with a braking device according to the invention. The projectile comprises a rear portion
10 1, a front portion 2, a payload 3, a sliding tube 5 on which there are fastened thin strips 4 and a support piece 6. The rear portion 1 of the projectile is set, for example, in the front portion 2 of the latter in the cut-out 9 represented in this figure. The two portions 1 and
15 2 are held in contact with one another by virtue of pins 12; it is at this point that the separation of the front portion 2 of the projectile from the rear portion 1 takes place. This separation is initialised, for example, by virtue of the impulse provided by a gas generator located
20 in the front portion 2 of the projectile and not represented in the figure, leading to the breaking of the pin 12, thus freeing the two front and rear portions of the projectile, as well as the payload contained inside the latter. In order to allow the insertion of the thin
25 strips 4 inside the structure of the projectile, an increase 10 in the clearances between the payload 3 and the projectile 2 has been produced. These thin strips 4 are arranged side by side inside the projectile thus forming a tube capable of sliding; they are also secured
30 at one of their end [sic] to a tube 5 on which there is placed a support piece 6; the shape of the latter is determined, for example, to include the bosses serving to support the bottom of the payload 3; it is produced, for example, from stamped sheet metal and its thickness is
35 determined, for example, as a function of the strength of the materials in order to avoid any deformation. At each of its ends, the support piece 6 is fitted, for example, with one or more studs 7 which, during ejection, come to

brace against a shoulder 8 forming an integral part of the rear structure 1 of the projectile and allowing the thin strips 4 to fulfil their role entirely; these studs 7 are produced, for example, so that they are withdrawn
5 elastically during integration into the projectile when they pass in line with the shoulder 8; they may also be secured, for example, to the thin strips (4) or to the tube (5) whilst maintaining their function.

Figure 2 represents a transverse section of the
10 rear portion 1 of the projectile during the separation phase. Indeed, when the projectile has left its launching tube, it is imparted with a rotational movement about the axis OO' . The separation of the front structure 2 of the projectile and of its rear portion 1 brings about the
15 freeing of the payloads contained inside the projectile. The front portion 2 of the projectile becomes propelled forwards by means of propulsive gases; the latter exert a force on the rear of the projectile facilitating, for example, the separation of the two portions 1 and 2 of
20 the projectile. As they move apart, the thin strips 4 are subjected to centrifugal force due to the rotation of the projectile. They thus exert a force which brings about a start of separation between the rear portion 1 and the payload 3. This phenomenon is obtained by the sliding of
25 the assembly 4, 5, 6 on the rear portion 1 of the projectile. It is thus possible to obtain a deployment length which is greater than that allowed by the space between the rear portion 1 and the payload 3. The sliding of this assembly 4, 5, 6 takes place as far as the stop
30 8 of the rear portion 1 where the studs 7 of the support piece 6 come to lock the assembly 4, 5, 6.

Figure 3 represents a transverse section of the rear portion of the projectile after the separation phase. Since the device according to the invention has
35 come into abutment against the notches provided for this purpose, the thin strips 4 are subjected to centrifugal force because the projectile has been set in rotation in its launching phase; they are deployed as a fan, by

bending, as shown in Figure 3, the speed of the projectile also producing effects on the latter. The combined effects of the aerodynamic forces due to the speed of the projectile and the centrifugal forces, on these thin strips 4, position them at, for example, an angle η ; this angle η , once reached, varies very little or not at all, this being by virtue of the structure of the thin strips produced, for example, from a metal or plastic material giving a plastic deformation, that is to say a deformation which is retained after the action of the combined effects on the thin strips. This principle makes it possible to increase the aerodynamic drag of the rear portion 1 of the projectile considerably.

Figure 4 represents a securing of the thin strips 4 according to another embodiment before the separation phase of the front portion 2 of the projectile and of its rear portion 1. The thin strips 4 are arranged side by side inside the projectile; they are housed between the rear portion of the payload 3 and the rear portion of the projectile 1; they are fastened at one of their end [sic] 12, for example, by a fixed securing system, for example, use may be made of rivets 13 which pass through the thin strips 4 and come to bear on the rear portion 1 of the projectile.

Figure 5 represents the securing system, previously described according to Figure 4, after the separation of the front portion 1 of the projectile and of its rear portion 2. Thin strips 4 secured on the rear portion 1, during the ejection of the front portion 2 of the projectile, are deployed and take up the position represented in Figure 5. The non-secured end 14 of the thin strips 4 comes to bear on the cutout 9 of the rear portion 1; it is at this moment that the thin strips 4 begin to fulfil, on the one hand, their separation role by virtue of the action of the self-rotation forces on the thin strips which causes a thrust force to be created on the front portion 1 thus facilitating the separation of the front portion 1 and of the rear portion 2; and, on

the other hand, their braking role thus allowing the payload 3 contained inside the projectile to be moved away with respect to its rear portion 1. .

Figure 6 represents a securing of the thin strips 4 according to another embodiment after the separation phase of the front portion 2 of the projectile from its rear portion 1. The thin strips 4 have the same arrangement as in the previous description; the difference lies in the securing system; they are secured, for example, to a moving securing system, for example, an axially sliding securing system which may be produced, for example, by a flat coil spring 15 whose large coil 16 is secured to the rear portion 1 of the projectile, for example, by pegs 17; the central coil 18 is fastened to the thin strips 4, for example, by a plate 19 fitted with two rivets 20. When the front portion 1 of the projectile is ejected, the central coil 18, which was superimposed over the large coil 16, moves longitudinally along the direction 00', and is stabilised in the position represented in this Figure 6 so that a portion 21 of the thin strips 4 is in a plane perpendicular to the central coil 18, as well as to the direction 00'. The thin strips 4 then fulfil the function which was described previously.

Figure 7 represents the deployment of the thin strips 4 according to the invention. These thin strips 4 are arranged either in one layer, which, in this case, brings about a fan-shaped deployment of the latter as shown by the thin strips 4 in solid lines in Figure 7, or in several layers, which makes it possible to obtain a deployment in the shape of a continuous crown. In the example represented in Figure 7, two layers of thin strips have been used: the first being drawn in solid lines 4, the other 11, in dotted lines. The two sets of thin strips each forming a tube in the state of rest inside the projectile, are offset by some angle in order to obtain the greatest possible braking surface; the latter is obtained when the spaces 11 between the thin strips 4 of the first thickness are covered by the thin

strips 10 of the second thickness. The shaping of these thin strips is given by the rotational movement of the projectile acquired at launching. The thin strips 4 are located one beside the other and form a tube inside the projectile when they are distributed around the payload 3. They are relatively thin and are produced, for example, from a metal or plastic material. The shape of these thin strips 4 is, for example, that of a flat rectangle whose width and length give their orientation which is defined by the ratio $\frac{\text{length}}{\text{width}}$; the latter must be

small in order to limit the risks of vibration due to the fact that the aerodynamic profile of the thin strips is unstable at high incidence. For the same objective, for example, the centre of aerodynamic thrust of the thin strips 4 may be off-centred. This may be produced, for example, by cutting out, lead weighting and by folding one of the edges of the latter; in this way, a stable angular setting is obtained with respect to the rotation, as well as a roll moment changing the roll law of the braked portion by using energy taken from the axial movement, which contributes to increasing the effectiveness of the device.

The device operates without using an extracting system and only undergoes disturbances due to its surroundings. It may even be employed in the case where, for example, the payload 3 of the projectile has air brakes fixed to its rear portion and opening under the influence of centrifugal force; the latter, during insertion inside the projectile before the separation and launch phase, may bear on the tube 5 which prevents their friction on the rear portion 1 during the sliding of the assembly 4, 5, 6 on the latter 1. In this way, the disengagement travel, with friction of the air brakes, is considerably reduced.

Figure 8 represents another application of the braking device with thin strips according to the invention. In this figure, the thin strips (4) are positioned, by one of their end [sic] (22), on a body

(23), for example, by setting the latter into the structure of the body, so that, during the deployment of the thin strips (4), as represented in the figure, each of them comes to bear on the rim (24) of the body in question in order to allow them to fulfil their role entirely, namely: with the body rotating, the aerodynamic effects due to the speed of the projectile and the centrifugal forces being exerted on the thin strips, the thin strips become positioned at, for example, an angle σ considerably increasing the aerodynamic drag and therefore braking the body. The thin strips (4) will be secured at the other end (25), for example, by a system of pins (26) which makes it possible to keep the thin strips in contact with the body in order to increase, in a first instance, the penetration of the body in the air and then to decrease the bulk; this securing system for the end (25) of the thin strips (4), in order to position the thin strips (4) along the body, may be produced particularly by a control system making provision for unlocking the securing system at a precise moment calculated previously. During the trajectory of the body, the aerodynamic forces act on the tear-off holes, consisting, for example, of the pins, the latter are freely torn off allowing the thin strips (4) to be deployed, fulfilling their braking function.

The arrangement of the thin strips (4) described in Figure 7 as well as any other means for securing the thin strips to a body may be envisaged in the application of the braking device which has been described previously.

This device according to the invention applies to any body imparted with a high rotational speed, and remains effective for rotational speeds which decrease, because once deployed, the device remains substantially in this position.

The invention may be applied particularly to any braking of a body, by replacing [lacuna] with a braking stage, as well as to pyrotechnic displays, for example

military ones, such as illuminators or infra-red illuminators which must be braked before the start of their operational phase.

The invention may also apply to sub-munitions loaded into a projectile. Indeed, in order to disperse each sub-munition after its ejection from the projectile, the device according to the invention may be secured to each sub-munition in order to brake, and therefore separate these sub-munitions. To do this, each sub-munition must be fitted with a specific number and dimension of thin strips in order to give them different speeds. With respect to Figures 9 and 10, the application of the device, according to the invention, to sub-munitions contained inside a projectile is as follows. In Figure 9, each sub-munition 27 placed inside the projectile 28 is covered with a compact system, in this case shims 29, and their securing system, for example, flyweights 30 so as, on the one hand, during ejection, to avoid generating, against the casing 31 of the projectile, considerable radial stresses due to centrifugal force, created by the projectile revolving about its longitudinal axis and, on the other hand, to resist the mechanical stresses due to the acceleration and imposed on the projectile at the beginning of the shot capable of damaging some sub-munitions. The device according to the invention must be arranged, for example, on each sub-munition, that is to say between the compact system and the sub-munition. Any other means for securing the thin strips to the body of the sub-munition may be used. In order to avoid a collision of the shims with the thin strips, which would particularly lead to a destruction of the thin strips, a system for delaying the opening of the thin strips 35 has been produced; this system, as represented in Figure 10, consists, for example, in putting as many metal tapes called foils 32 as shim elements, not shown. These foils, for example made from thin sheet metal are wound around the sub-munition 33 in the opposite direction to the direction of rotation with a

winding angle limiting the risk of collision; this winding angle is a function of the number of shim elements and of the position of the junction between two shim elements with respect to the securing of the foil, 5 for example on the sub-munition, for example by welding 34 at one of its ends. For example, for three shim elements at 120° , each foil is surrounded [sic] around the sub-munition with a winding angle of the order of 285° . The securing of the foil to the sub-munition is 10 done so that the tangential holding is consecutive but the radial holding is lower so that the foil secured, for example, by welding, does not resist centrifugal force which brings about the ejection of the latter.



CLAIMS

1. Device for braking an element of a projectile, having a longitudinal axis 00' and intended to be driven with a rotational movement, the projectile comprising a front portion (2) and a rear portion (1) each having a body, an assembly of the two bodies forming a body of the projectile, the external peripheral surface of the body of the projectile delimiting an internal portion and an external portion, the front (2) and rear (1) portions being able to be separated from one another, the rear portion (1) comprising means of braking capable of two positions: a first position when the front (2) and rear (1) portions are assembled, and a second position when these portions are separated, the braking means consisting of surfaces which in the first position are lodged in the portion internal to the body of the projectile and which in the second position are at least partially deployed outside the body of the rear portion (1), characterised in that the surfaces consist of thin strips (4) made from a material capable of plastic deformation and secured by one of their ends to the periphery of the body of the rear portion, passage from the first to the second position being obtained after separation of the front portion and of the rear portion under the effect of centrifugal forces.
2. Device according to Claim 1, characterised in that the thin strips (4) are secured to a tube (5) of axis 00'.
3. Device according to Claim 2, characterised in that the tube (5) is capable of two positions: a first position before separation, and a second position after separation, passage from the first to the second position consisting of sliding towards the front along the axis 00'.
4. Device according to one of Claims 2 or 3, characterised in that the tube (5) is secured to a support piece (6) which comprises, at each of its end [sic], studs (7) interacting with the rear portion so as to



prevent the piece (6) from leaving the rear portion (1).

5. Device according to Claim 4, characterised in that the locking of the device, effected by the studs (7), during sliding of the tube (5), of the thin strips (4) and of the support piece (6), is performed by setting
5 the studs (7) into a stop (8) fixed on the rear portion.

6. Device according to one of Claims 2 or 3, characterised in that the tube (5) comprises studs interacting with a stop (8) of the rear portion so as to prevent the
10 tube (5) from leaving the rear portion.

7. Device according to Claim 1, characterised in that the thin strips (4) are secured to the rear portion of the projectile (1) by rivets (13).

8. Device according to Claim 1, characterised in that the thin strips (4) are secured to the rear portion
15 (1) by a flat coil spring (14) sliding axially.

9. Device according to Claim 8, characterised in that the flat coil spring (14) is secured to the rear portion (1) of the projectile.

20 10. Device according to one of the preceding claims, characterised in that the thin strips (4) are, in the first position, arranged in one layer.

11. Device according to one of the preceding claims, characterised in that the thin strips (4) are, in the
25 first position, arranged in several layers.

12. Device according to Claim 10, characterised in that the thin strips (7) are deployed in the form of a discontinuous crown.

13. Device according to Claim 11, characterised in that in the deployed position the thin strips (4) form a
30 continuous crown.

14. Device according to one of the preceding claims, characterised in that the centre of aerodynamic thrust of the thin strips (4) is off-centred by lead weighting or
35 other means so as to obtain a stable angular displacement of the strips.



15. Device according to one of Claims 1 to 14, characterised in that before separation of the front (2) and rear (1) portions, the body of the projectile houses bodies (23) or sub-munitions (27) capable of leaving the body of the projectile after separation.

16. Device according to Claim 15, characterised in that the bodies (23) or the sub-munitions (27) are equipped with thin strips (25, 35) which are plastically deformable and are capable of two positions: a first position when the body (23) or the sub-munition (27) is inside the projectile and a second position when the body (23) or the sub-munition (27) is outside the projectile, and in that in the first position at least a portion of the surface of each thin strip is arranged along the peripheral surface of the munition, and in that in the second position at least a portion of the surface of each thin strip is deployed radially towards the outside of the body or of the sub-munition.

17. Device according to Claim 16, characterised in that metal foil (32) is wound around the sub-munition (33) on the thin strips (35) so as to prevent a rapid opening of the device.

18. Device according to Claim 17, characterised in that the metal foil is secured by one of its ends by welding (34).

19. Device according to one of the preceding claims, characterised in that the securing system is a control system.