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Simmons et al.

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[45] **March 6, 1973**

[54] **DEVICE FOR A PROJECTILE**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **244/3.27,** 102/35.6

[51] **Int. Cl.** **F42b 13/32,** F42b 13/38

[58] **Field of Search** 244/3.23, 3.24, 3.25, 3.26, 244/3.27, 3.28, 3.29, 3.3; 102/49.4, 93, 35.6, 37.6

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Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—James M. Hanley
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[57] **ABSTRACT**

A device separable from a projectile arranged to be fired from a rifled barrel. The device includes a unit such as a flare supported by a parachute which is expelled from the projectile a predetermined time after firing of the projectile. The unit is placed in a container which is initially closed at one end by a bottom plate which also constitutes the bottom plate of the projectile and is capable of sustaining the powerful gas pressure generated when the projectile is fired. Upon expulsion of the container from the projectile by a suitable timing and expelling assembly, the container separates into several parts and a brake mounted on the unit is activated by the centrifugal force and causes a slowdown of the unit. The bottom plate which is also subject to the centrifugal force is pivotally connected to the unit by a pivot means which is eccentrically disposed with respect to the lengthwise center axis of the container and thus of the unit. The combined action of the centrifugal forces acting upon the brake and the bottom plate cause the latter to pivot into an angular position in which it is released from the pivot means and is thus ejected out of the linear path of the unit, thereby preventing collision with the same.

12 Claims, 11 Drawing Figures

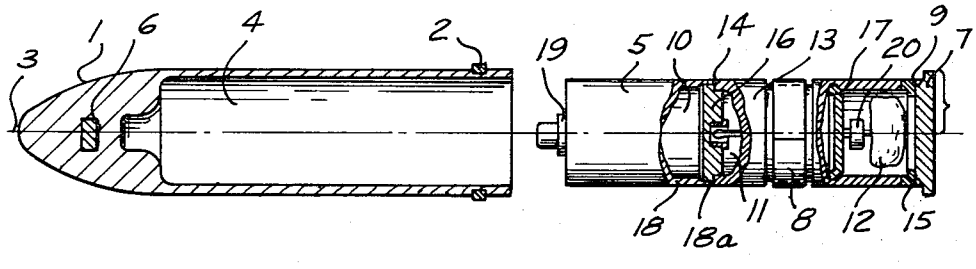


FIG. 1

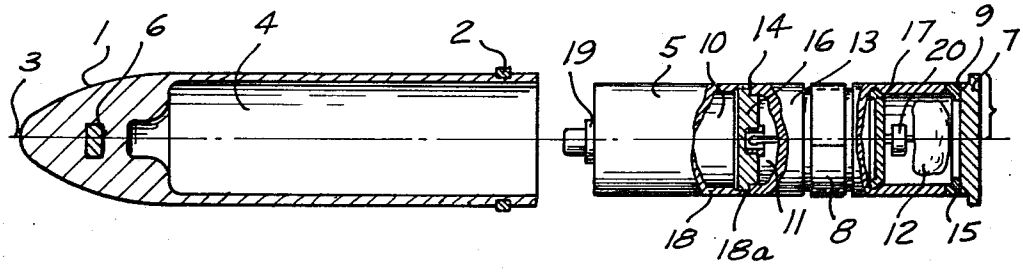


FIG. 2

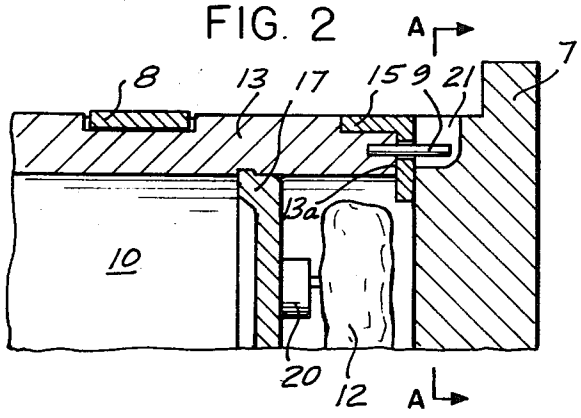


FIG. 3

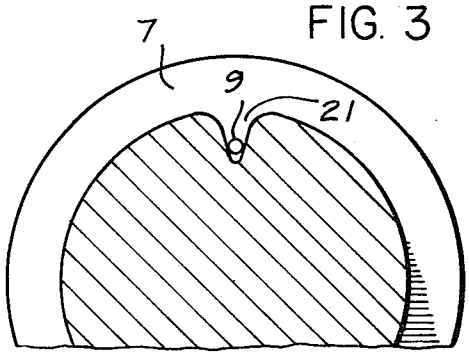


FIG. 4

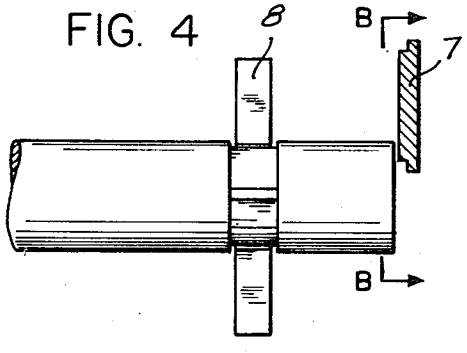


FIG. 5

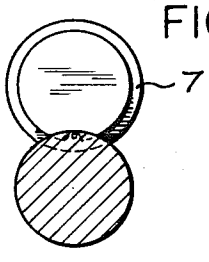


FIG. 6a

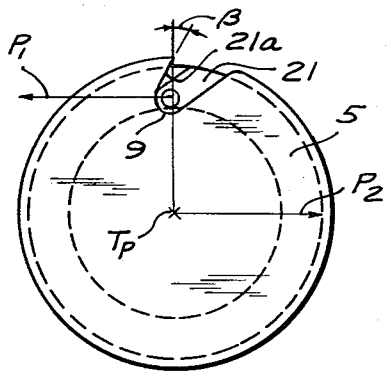


FIG. 6b

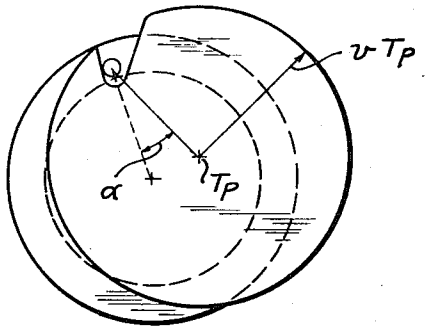


FIG. 6c

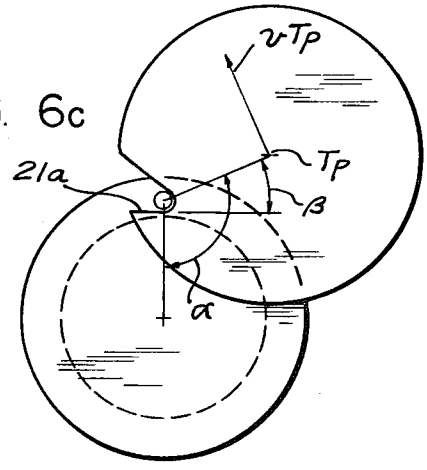


FIG. 7a

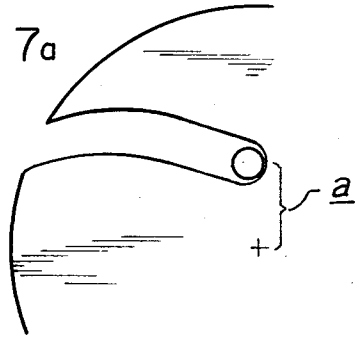


FIG. 7b

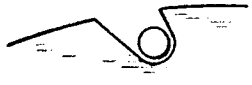
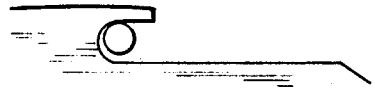


FIG. 7c



DEVICE FOR A PROJECTILE

The present invention relates to a device for a unit that can be fired with a projectile and is placed in a space in the projectile, from which the unit separates at a given time after the projectile has been fired so that, together with the bottom plate of the projectile, it rotates around an axis of symmetry which is common for the unit and the plate. The unit is also provided with a rotation brake, which when activated causes an angular retardation of the unit. By unit is meant, in the present case, a unit containing a composition of some kind, e.g. a flare or smoke charge, with one or a plurality of parachutes belonging to same which are to open after the movements of the charge have been braked up around and along the axis of symmetry, so that the charge depending from the parachute or parachutes can descend slowly towards the ground. The braking of the movement of the unit along the axis of symmetry is achieved, as a rule, by a brake parachute which is to be activated at or after the separation of the unit from the space.

Said projectile is fired from a barrel with the aid of a propellant charge which when fired develops a gas pressure that propels the projectile, and the bottom plate of the projectile then constitutes an essential part of the actuation surface for the gas pressure. This involves that the bottom plate must be made so that it is comparatively strong, and at least when the projectile is of a large caliber, it will then constitute a massive and heavy member. For projectiles of this kind, the massive and heavy bottom plate has involved serious drawbacks, as when the charge (the unit) carried in the parachute has been fired from the space in the projectile, it has remained in the trajectory of the charge and has followed this, so that when the brake parachute has opened and braked the charge, the bottom plate has hit the parachute and charge and damaged same.

For the purpose of eliminating this problem, it has been proposed to give the bottom plate an eccentric design, and the bottom plate will then, as a consequence of the angular rotation it has obtained in the projectile around the line of symmetry, be given a trajectory that deviates from that of the charge. However, it has proved that it has not been possible to make the bottom plate sufficiently eccentric, without creating stabilization problems in the actual projectile. Insufficient eccentricity has involved that the deviation of the trajectory of the bottom plate in relation to the trajectory of the charge has not been as great as desired, for which reason the risk that the bottom plate would damage the unit has still remained.

To illustrate this, it can be mentioned that for a projectile rotating with a speed of 6,000 r.p.m. and which is provided with a bottom plate with a radius of 70 mm, a displacement of the center of gravity of the bottom plate of 3 mm is reasonable. The tangential speed arising in the bottom plate when the unit leaves said space, caused by the displacement of the center of gravity, and with which the bottom plate thus leaves the trajectory of the unit, will consequently be approx. 2 m/sec. ($= 2\pi \cdot 0.003 \cdot 100$). In order that the parachute of the unit shall open, the bottom plate must have travelled 70 mm laterally, i.e. at least so far that the unit and the bottom plate will be located tangentially in relation to each other. For this, with the eccentricity in question, the bottom plate will require no less than 0.035 secs. (0.070/2). If it is assumed that the bottom plate is moreover still in the tangential position in relation to the unit, or is only slightly further displaced in relation to this when the brake parachute is opened and begins to brake the unit, the bottom plate with its axially unbraked mass will start to pass the unit very close to this, which would have the result that the bottom plate would hit the flaps comprised in the rotation brake of the unit, unless either the activation of the brake parachute or the rotation brake is delayed so that the bottom plate will have time to travel sufficiently far out laterally or pass the rotation brake axially. Calculations and tests have shown that if assurance should be obtained for all dimensions of flaps, the bottom plate with the eccentricity of 3 mm must be given a time of at least 0.1 sec. before efficient braking of the unit can commence, which is an altogether too long time with consideration to the functioning on the whole of the flare, and also involves that the unit must be provided with special members, complicating the unit, which delay the activation of the brake parachute and/or the rotation brakes, since the time in question cannot be shortened through the application of greater eccentricity.

The present invention relates to a device which solves the above-mentioned problems entirely, in that it can achieve a tangential initial velocity of the bottom plate which is considerably higher than has hitherto been obtained, and this can even be accomplished without having to make the bottom plate eccentric, which in turn involves that the original high degree of functioning of the actual projectile can be maintained, and also that the qualified processing required for obtaining such eccentricity can be eliminated entirely. The feature that can be considered to characterize a device according to the invention is that the unit and the bottom plate are connected at the separation from the space in the projectile through a connecting part which is placed at a predetermined distance radially from the axis of symmetry, whereby the angular rotation of the bottom plate before the activation of the rotation brake will be adapted to the angular rotation of the unit, and in that the bottom plate is rotatable around its fastening point in the connecting part, so that the angular retardation arising at the activation of the rotation brake will cause a rotating movement of the bottom plate around the connecting part, and in that the connecting part is then arranged to allow the bottom plate to become separated from the unit when it has executed a rotating movement of a certain size.

An embodiment which has the characteristics significant for the invention will be described in more detail with reference to the attached drawings, in which

FIG. 1 in a side view and partly in cross section shows a unit which has just become separated from the space in the projectile, the unit being assumed to be connected with the bottom plate of the projectile;

FIG. 2 in a side view and in cross section shows the connecting part between the unit and the bottom plate according to FIG. 1;

FIG. 3 shows an end view of the unit and the bottom plate according to FIG. 2 (section A—A);

FIG. 4 in a side view and partly in cross section shows the bottom plate as having executed a rotating movement of the predetermined size around the connecting member;

FIG. 5 shows a device of the unit and bottom plate according to FIG. 4 (section B—B);

FIGS. 6*a* – 6*c* show in end views three positions the bottom plate occupies in relation to the unit from the moment the angular retardation of the unit occurs;

FIGS. 7*a* – 7*c* show in end views alternative embodiments of recesses in the cases when the connecting part comprises a pin and a recess.

In FIG. 1, 1 shows a projectile which is fired from a barrel, the projectile having a member 2 which coacts with the rifling in the barrel, and which achieves that the projectile, in addition to a movement along its axis of symmetry 3, is also given a rotating or spin movement about same axis. The projectile 1 also has a space 4, in which a unit 5 can be placed.

At a given time after the projectile has been fired from the barrel, the unit is separated from the space by the initiation of a separating charge 6 located in the projectile. The unit is expelled through the rear part of the projectile, so that the unit together with the bottom plate 7 of the projectile will rotate around the axis of symmetry 3, which can be assumed to be common for the unit and the bottom plate. FIG. 1 is intended to show the instant when the separation takes place, at which instant it is assumed, in order to facilitate the description, that a rotation brake 8 on the unit has not yet been activated. The unit 5 and the bottom plate 7 are connected via a connecting part which is diagrammatically indicated by 9 in FIG. 1, and which is placed at a predetermined distance *a* radially from said axis of symmetry 3, whereby the angular rotation of the bottom plate before the activation of the rotation brake 8 will be adapted to the angular rotation of the unit.

In the example of the embodiment, the unit contains a flare 10 together with its main parachute 11 and a brake parachute 12. At the firing, the two parachutes are protected by an enclosing member 13, which consists of a number of parts that are parallel with the axis of symmetry 3 and which at this stage of the sequence of the firing of the unit are held together at one end by a container 14 and their other end by a ring 15. The enclosing member 13 is provided with fastening parts 16 and 17 to accommodate the fastening parts of the main parachute 11 and the brake parachute 12. Said rotation brake 8 is arranged in the enclosing member 13, and consists of four flaps which are swung out by the centrifugal force generated by the rotation. The flare 10 is placed in an inner container 18 which, in turn, is placed in the container 14, and which moreover with an edge 18*a* is fastened in the fastening parts 16 for the main parachute. Finally, the container 14 includes a further delay composition 19, which is ignited at the separation of the unit from the projectile, and which, when initiated, blows away the container 14 so that the flare 10 with its inner container 18 together with the main parachute 11 can be released from the other parts of the unit when the movements of the unit along and around the axis of symmetry have been braked by the rotation brake 8 and the brake parachute 12 to a sufficient degree. The brake parachute is fastened in its fastening part 17 via a ball bearing 20, which prevents the cords of the brake parachute from twisting at the braking.

FIG. 2 shows an enlarged view of how the connecting part 9 is arranged. The connecting part, which in the example of the embodiment consists of a pin, is fastened at one end of the enclosing member 13, from which end surface 13*a* the pin extends through a hole in the ring 15 into a coacting recess 21 in the bottom plate. The bottom plate is rotatable in its fastening point for the pin 9, and the shape of the recess facilitates the releasing of the bottom plate when it has executed the necessary rotating movement. In the corresponding way, the unit is rotatable in the recess 21 in the opposite direction in relation to the direction of rotation of the bottom plate.

In FIG. 4, the braking member 8 has been activated and has started to function, and in this way has achieved an angular retardation of the unit, which retardation causes the bottom plate to turn around the pin, and as the retardation is very great at the beginning of the braking of the rotation, if there are fairly large values of the predetermined distance a (FIG. 1), in a very short time the bottom plate will be given a rotating speed around the pin 9 and, accordingly, a tangential center of gravity speed of considerable size in this connection. Thus, at tests carried out with a bottom plate with a radius of 70 mm, at 6,000 r.p.m. and with the connecting part peripherally arranged, a transversely directed speed of the bottom plate of more than 30 m/sec. has been measured, i.e. an improvement of more than 15 times in comparison with the above-mentioned case with the 3 mm displacement of the center of gravity of the bottom plate. Such an initial velocity causes the bottom plate to be separated from the unit in very short time, and that there is no risk that the plate will, for instance, collide with the flaps of the rotation brake, which involves that the activation of the rotation brake and the brake parachute can take place very rapidly and that the functioning of the system itself of the projectile and the unit need not be modified in any other respects. FIGS. 4 and 5 are intended to show the instant when the bottom plate has turned with a rotating movement of the size required, and at which the unit and the plate are just about to be separated from each other. At the same time as the bottom plate is given its high, laterally directed speed, a speed in the opposite direction is obtained in the unit (angular movement) which contributes to a good result. The size of the movement in the opposite direction is dependent on, inter alia, the mass of the bottom plate use.

When designing the connecting part, such as a pin, it is of importance that the connecting part is given such dimensions that it will withstand the shearing forces that arise. Instead of being fastened in the enclosing member 13, a part replacing this member, or in the flare itself, the pin can very well instead be fastened in the bottom plate, and the coacting recess can then be arranged in said member, part or flare. Likewise, the predetermined distance can be made different in each individual case; and it also conceivable to design the connecting part so that said distance can be made adjustable. The best effect is obtained if the connecting part is arranged peripherally, which positioning is particularly favorable for projectiles that have low rotating speeds. For projectiles with high rotating speeds, it can be necessary to limit the forces arising in the bottom plate and the unit at the retardation, which can be accomplished by, for instance, reducing the distance *a*, the choice of a small size of the angular rotation of the

bottom plate before it is released from the connecting part, or through a special design of said recess, which is applicable only in cases when such a recess is used.

FIG. 6*a* shows an example of an embodiment in which the connecting part 9 consists of a pin fastened in the unit 5 which coacts with the recess 21 in the bottom plate. The figure shows the conceived instant when the angular retardation of the unit just occurs, at which a pair of forces P1 and P2 are formed through the connecting part and the center of gravity Tp of the bottom plate, which pair of forces strives to turn the bottom plate around the pin. As will be noted from the figures, the side surface 21*a* of the recess 21 is inclined at an angle β in relation to a line through the pin and the center of gravity Tp, an inclination which moreover can be seen as positive in contrast with negative inclination.

In FIG. 6*b*, the bottom plate has turned an angleα in relation to the bottom plate, which in said FIG. 6*b* is of the same size as the angle β and during this rotation the bottom plate has been given a speed vTp of the force P2.

Further, in order that the pin shall slip out of the recess 21, the bottom plate must execute a further angular movement such that the friction between the pin and the bottom plate is overcome, and this further angle is designated the fiction angle γ. From this it will be realized that the bottom plate is released when the angle of rotationα is greater than the sum of the angle of inclinationβ and the friction angleγ, of which latter angular relation FIG. 6*c* is intended to give an example. Whenα is greater than the two other angles together, the center of gravity Tp has obtained the speed vTp tangentially. During the latter part of the release of the bottom plate, the bottom plate obtains additional speed when the pin slips out along the side surface 21*a* of the recess. This additional speed can be utilized in cases when the retardation forces arising are very great so that there are difficulties involved in dimensioning the pin so that it will be sufficiently strong. At said dimensioning difficulties, as mentioned above, the distance *a* can be made small, at the same time as the angle of inclination β is made negative, and a slipping movement then occurs after only a small angle of rotation, so that the major portion of the lateral speed of the bottom plate is obtained through the slip-off movement.

FIG. 7*a* shows an example of where the slip-off movement is utilized to achieve the speed of the bottom plate. The distance *a* is small and the angle of inclination β is negative. FIGS. 7*b* and 7*c* give examples of other designs of the recess and other positionings of the pin in relation to the common line of symmetry of the unit and the bottom plate, and 7*b* then shows the recess with a negative angle of inclination.

As regards the size of the angle of rotation the bottom plate is to be given before it is released, as indicated above, this can be chosen from very small angles to angles of more than 180°, but particularly angles within the range of 45° to 180° seem to be advantageous. When choosing the size of said angle of rotation, consideration should be taken to the opposite rotating movement of the unit.

The invention is not limited to the embodiment shown above as an example, but can be subject to modifications within the scope of the following claims. Thus, for instance, the unit and the bottom plate can be varied within wide limits without deviating from the concept of the invention, and likewise the connecting part can be designed in a number of different ways. The above-mentioned recess, for instance, can be omitted, and the pin can be fastened in both the unit and the bottom plate, and can also be made so that there will be a breakage of its material or its fastening when the bottom plate reaches its releasing angle. In the last-mentioned embodiment, the pin can moreover be replaced by a torsion bar or a helical spring. The spring can then be present to give a greater rotating speed, which can be an advantage for projectiles with low rotating speeds and angular retardation. The connecting part can also consist of two parts, each of which are fastened in the unit and the bottom plate, respectively, which parts are engaged in each other until the bottom plate has executed its turn to the releasing angle, when said engagement is released. If again, a pin is utilized, this can be given a conical shape, whereby the coaction can be obtained by means of a suitable hole. Finally, the pin can be replaced by a cleat, link, ball etc.

We claim:

1. A device including a separable unit and arranged to be fired from a rifled barrel, said device comprising in combination:

a shell casing containing an ignitable gas generating charge and a projectile fitted into an open end of the shell casing to impart a longitudinal and rotary acceleration to the device by gas pressure generated by ignition of the charge in the shell casing, said projectile being hollow and open at its end facing the shell casing for accommodating in the projectile a unit arranged to be separated from the projectile through the open end thereof a predetermined period of time after firing of the projectile, a container slidably fitted into said projectile and open at its end adjacent to the open end of the projectile, said container being arranged to separate into several parts on removal from the projectile through the open end thereof and including said unit and further including a brake means responsive to a centrifugal force for activation, activation of the braking means reducing the rotational speed of the unit; a bottom member for closing the open end of the container and also the open end of the projectile; connecting means connecting said bottom member for releasably retaining said bottom member on the container pivotal between a closing position in which the lengthwise center axis of the bottom member coincides with the lengthwise center axis of the container and a release position in which the bottom member is laterally displaced relative to the container axis, said connecting means including a pivot means and a receiving means therefor on the unit and the bottom member respectively, said receiving means retaining the bottom member when in said closing position but freeing it for separation from the unit when in said release position; and timing and expelling means for expelling the container from the projectile a predetermined period of time after firing of the projectile, expulsion of the container freeing said braking means for activation by the centrifugal force to cause slowing of the rotational

speed of the unit and causing said bottom member to be pivoted by the centrifugal force out of its closing position into its release position in which it separates itself from the pivot means and is laterally ejected out of the linear path of the unit.

2. The device according to claim 1 wherein the radial distance between said connecting means and the lengthwise center axis of the container is smaller than the radius of said unit with reference to the center axis of the container by a length such that the connecting means are located substantially in the peripheral outline of the container.

3. The device according to claim 1 wherein said pivot means and said receiving means are respectively in the form of a pivot pin and a recess engageable with the pin, said pin being disposed substantially parallel with the lengthwise center axis of the unit.

4. The device according to claim 1 wherein said recess is formed in the bottom member and elongate toward the center axis of the container, the pin being located at the inner end of the recess when the bottom member is in its closing position and the recess extending toward the peripheral outline of the bottom member with a curve toward the direction in which the bottom member is pivoted about the pin by the action of the centrifugal force, whereby the moment of force tending to pivot the bottom member increases and the moment of force generated by the pivoting of the bottom member about the pin decreases correspondingly.

5. The device according to claim 1 wherein said pivot means is a pin extending substantially parallel with the lengthwise center axis of the container and said receiving means is in the form of an elongate recess engageable with the pin, said recess having a configuration such that pivoting of the bottom member from its closing position into its release position requires a turning angle in the range of 5° to 270°.

6. The device according to claim 5 wherein said turning angle of the bottom member is within the range of 45° to 135°.

7. The device according to claim 1 wherein the pivot means included in the connecting means is in the form of a pin fastened to said unit and said bottom member, said pin being dimensioned and arranged to break either at the unit or the bottom member in response to a pivoting of the bottom member through an angle of rotation in excess of a predetermined value.

8. The device according to claim 1 wherein said pivot means included in the connecting means comprises a torsion bar secured to said unit and said bottom member, said torsion bar being designed to break loose in response to the bottom member pivoting through an angle in excess of a predetermined angle.

9. The device according to claim 1 wherein said pivot means included in the connecting means comprises a spring secured to said unit and said bottom member, said spring being designed to break the connection between the unit and the bottom member in response to the bottom member pivoting in excess of a predetermined angle.

10. The device according to claim 9 wherein said spring is disposed so as to bias the bottom member for pivoting in the direction toward its release position thereby increasing the pivoting speed of the bottom member.

11. The device according to claim 1 wherein said pivot means is in the form of an elongate element and said receiving means is in the form of a recess engageable with said elongate member.

12. The device according to claim 1 wherein said pivot member is in the form of a ball and said receiving means is in the form of a recess engageable with said ball.

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