July 9, 1968 F. GENCO 3,391,885

CONTAINER FOR FREE FALL IMPACT

Filed Nov. 4, 1966 2 Sheets-Sheet 1

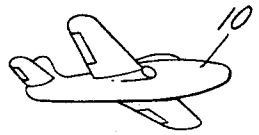


FIG. 1.

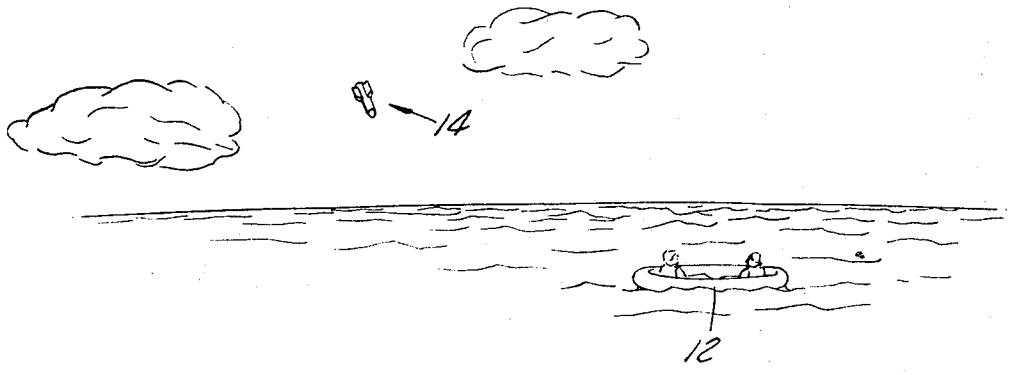
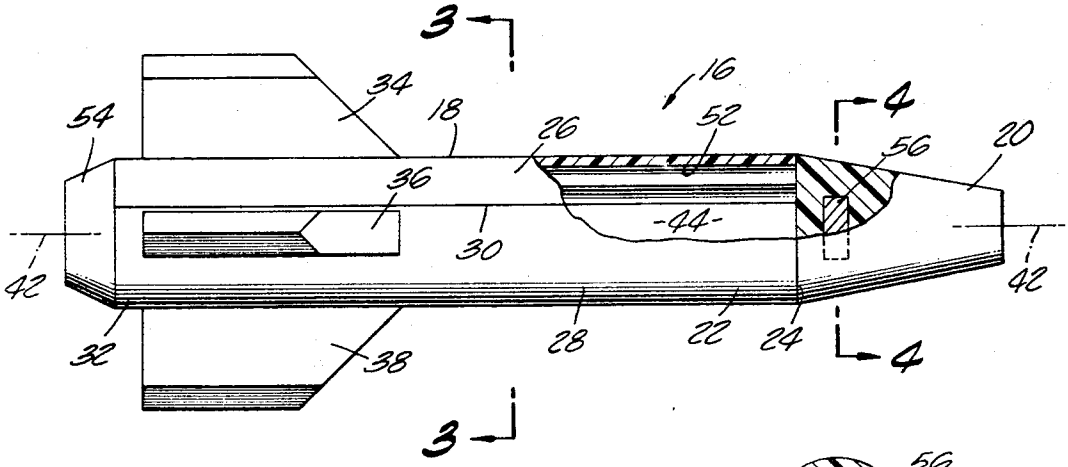


FIG. 2.



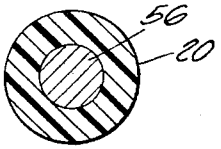


FIG. 4.

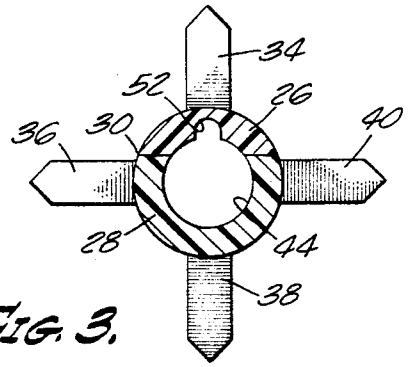


FIG. 3.

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CONTAINER FOR FREE FALL IMPACT

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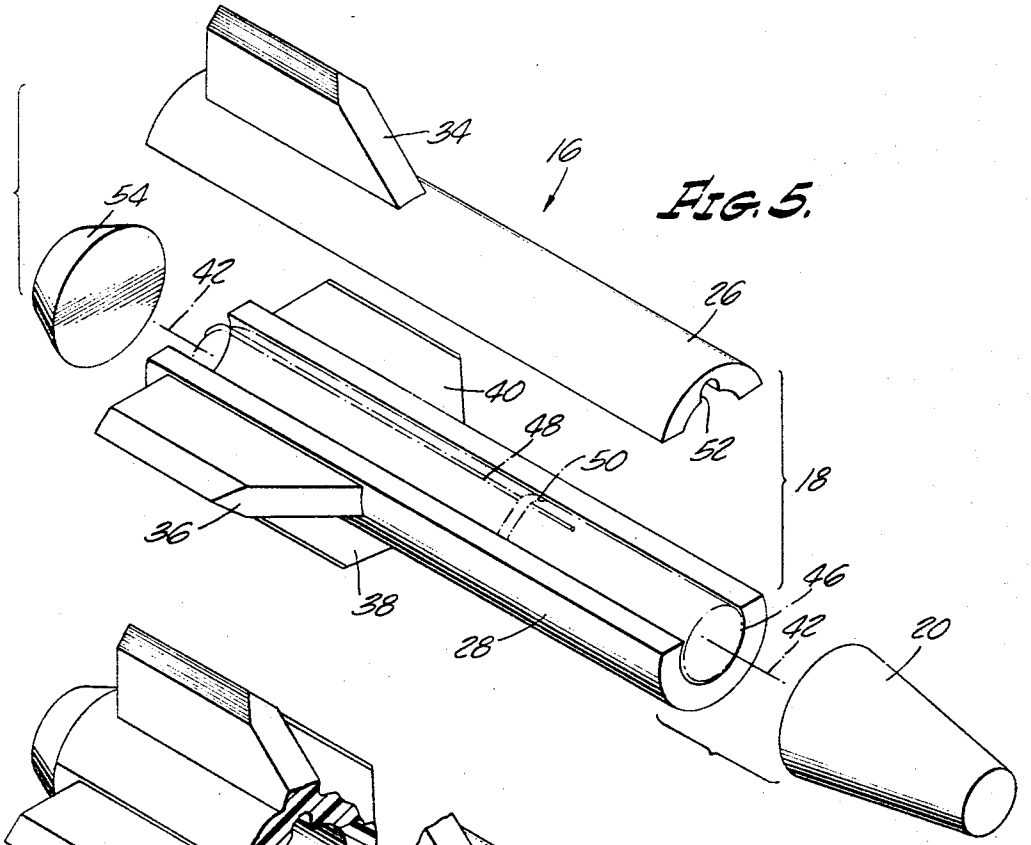


FIG. 5.

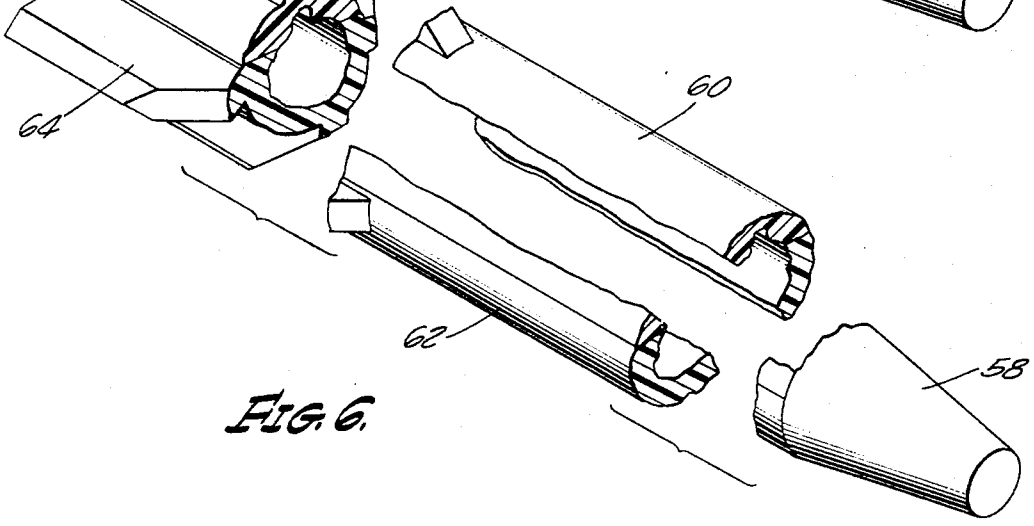


FIG. 6.

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United States Patent Office 3,391,885 Patented July 9, 1968

3,391,885

CONTAINER FOR FREE FALL IMPACT

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Filed Nov. 4, 1966, Ser. No. 592,007
5 Claims. (Cl. 244—138)

ABSTRACT OF THE DISCLOSURE

A droppable container has an elongate hollow chambered body portion with fins at one end and a nose portion at the other, all being formed of a readily fragmentable material having a maximum density of about 6 pounds per cubic foot, but preferably of no more than about 2.5 pounds per cubic foot. Preferably, the projected frontal area of the body portion alone is about twice that of the chamber, and the projected frontal area of the fins is approximately the same as that of the body portion.

This invention relates generally to the packaging art, and is particularly concerned with a container intended for the impact-deceleration of the container contents from a free fall, the said container being crushed and/or fragmented upon impact so as to free the contents from the container substantially without impact injury or damage thereto, when the container contents are ejected, launched, or otherwise debouched from an aircraft. For simplicity of exposition, the container and enclosed contents will be referred to hereinafter as the package.

It is a general object of the invention to provide a packaging container for a device which provides a package of substantially high integrity during normal storing, handling and transportation procedures, and particularly during launching or ejection from an aircraft in flight and during free fall to the instant of impact.

It is another object to provide a container as aforesaid which is shorn of its integrity substantially almost immediately upon impact or immediately thereafter, in order that the contained device shall be freed of the container for immediate operation and utility.

It is a further object to provide a packaging container, the structure of which is a generally elongated body portion provided with a nose portion, the whole constituting an aerodynamic structure which will impact substantially on the nose portion from a free fall.

Another object of the invention is to provide a packaging container, as aforesaid, having a generally elongate cylindrical body configuration, said body having a longitudinal axis therethrough about which is defined a hollow cylindrical chamber adapted to receive and confine the device to be dropped from an aircraft in flight. In a container according to this object, the center of mass of the enclosed device will lie substantially on or near the longitudinal axis of the container body portion, hence the force of deceleration upon impact will be directed toward the container nose.

It is an object to provide a low density packaging container, according to the object aforesaid, in which the frontal area of the package in free fall flight is considerably larger than the largest cross-sectional area of the contained device, as measured normal to its longitudinal axis. In a preferred embodiment the ratio of container frontal area to cross-sectional area of the device is of the order of about 9 times.

It is a specfic object to provide a packaging container with aerodynamic properties which will orient the package quickly upon launch into free fall from low to high altitudes, such that impact will occur in a specific orientation with respect to the contained device. Preferably, the high deceleration force at the impact is substantially a compressive force exerted along the line of the greatest strength of the device, thereby eliminating to the greatest extent possible any bending forces, for examples, on elongate contained devices.

A specific object of the invention is to provide a low cost packaging container comprised of a material having a density substantially less than that of water, usually a density of 6 pounds per cubic foot, or less. Preferably, the density of the material is no greater than 2½ lbs. per cubic foot, hence is very buoyant and resistant to submersion. A further preferred property of the container material is that it be substantially crush- or break-resistant during normal storing, handling and transportation procedures for the package, but that the container should positively fragment upon impact, either from the force of the impact itself or else from the drag forces exerted on the container body upon entry of the package into water. Of course, the crush- or break-resistance has to encompass the various aerodynamic compression, tension, bending and shear stresses to which the package would be subjected by the atmosphere in the interval from launch to impact.

It has been discovered that cellular polystyrene plastic material is substantially completely satisfactory for the fabrication of packaging containers for devices according to the foregoing objects. As is well known, cellular polystyrene consists of polymerized styrene expanded many times in volume. Also, as is known, it is formed by the expansion of high density beads or granules in a mold or directly from the base resin by extrusion to form an extremely lightweight material which is firm in composition and essentially unicellular. The manufacturing process, which is well known, forms no part of the present invention.

Although containers according to the present invention are preferably fabricated from cellular polystyrene it is obvious that they might be fabricated from other materials such as paper pulp fiberboard or cellular cellulose acetate, for example. The essential limiting requirements for such containers are that the containers must have limited cohesive strength which will survive environmental conditions prior to and during launch and free fall, and then break up, at least partially, upon impact.

A preferred embodiment of the invention will now be described in connection with the drawings without intent to limit the invention to such an embodiment. Referring to the drawings:

FIG. 1 is a pictorial illustration of the invention in one use for which it may be employed;

FIG. 2 is a side elevation, partly broken away, of a preferred embodiment of the invention;

FIG. 3 is a cross sectional elevation view taken on the line 3—3 of FIG. 2;

FIG. 4 is a cross sectional view taken on the line 4—4 of FIG. 2;

FIG. 5 is an exploded perspective view showing the parts of a preferred form of the invention; and

FIG. 6 is an exploded perspective view showing a typical random fragmentation pattern of the container parts which results from an impact with water.

In FIG. 1 there is shown pictorially a search aircraft **10** which has located a life raft **12** with survivors. A datum marker beacon package **14** has been launched from the aircraft **12**. The package **14** comprises an emergency radio beacon device which, upon impact of the package **14** with the water, is freed therefrom by fragmentation of the container which encloses the beacon device. The beacon device, per se, forms no part of the present invention and is not shown, except in phantom

in FIG. 5, nor will it be described except very briefly in connection with that figure.

Referring to FIG. 2, the container **16**, of which the package **14** of FIG. 1 is comprised, includes an elongate cylindrical body portion **18** and a nose portion **20** which is preferably configured in the form of a frustum of a cone. The nose portion **20** is bonded, cemented or otherwise secured to the fore-end **22** of the body portion **18** at the parting line **24**. The body portion **18** is comprised of upper and lower body elements **26** and **28**, respectively, joined and bonded at the parting line **30**. Referring to FIGS. 2, 3, 5 and 6, it will be observed that the aft end **32** of the body portion **18** is provided with aerodynamic guide fins **34**, **36**, **38** and **40** which are preferably formed integrally with the elements **26** and **28**, although they may be separately formed and cemented or otherwise secured thereto. If separately formed, it is desirable that the bond of the fins **34**, **36**, **38** and **40** to the elements be stronger than the strength of the material of which the various parts are fabricated.

In FIG. 5 the elongate body portion comprised of the upper and lower elements **26** and **28** is cylindrical in configuration about the longitudinal axis **42**. The elements **26** and **28** define an elongate partly cylindrical hollow chamber **44** (FIG. 3) which is adapted to enclose a device such as a radial marker beacon, shown in phantom at **46** and including a folded antenna **48** retained in the position shown by, for example, a water soluble tape **50**. Forming a part of the chamber **44** is a longitudinal groove **52** which is adapted to accommodate the antenna **48**. An end cap **54** may be cemented to the aft end **32** of the container to fully enclose the chamber **44** after the beacon device **46** is nested therein.

The chamber **44** is arranged to enclose the beacon device **42** only somewhat loosely. In a typical embodiment, for example, the beacon device has a diameter of 2¾ inches while the diameter of the chamber is about 3¾ inches. This arrangement is regarded as important in that the beacon device should have relative freedom of movement with respect to its enclosing container along its axis, or along the axis **42** of the container **16**, when the package impacts upon landing, particularly so if the impact landing is on water.

The nose portion **20** is preferably of solid construction, and may have a weighted mass **56** molded therein for a purpose to be described. Preferably, the center of mass of the weighted mass **56** will lie on or adacent to the longitudinal axis **42** of the body portion **18**.

The container **16** as thusly described and the device enclosed by it, comprises a package which, upon launch or ejection from an aircraft, is immediately subjected to aerodynamic forces due to the relative difference between the forward velocity of the aircraft and that of the air. Furthermore, the passage of the aircraft through the air disturbs the latter very greatly and causes a local roily condition which stresses the container in tension, compression, bending and shear very abruptly and unpredictably. This is because the package will usually be carried within the aircraft and not suspended from it in the air stream as would be the case with a bomb or missile, for example. However, the structure as described aforesaid is quickly righted for a nose down free fall, as pictorially shown in FIG. 1, for impact on its nose portion.

It will be observed that the preferred structural arrangement of the body portion **18** is such that the sudden force of impact or shock load is directed substantially along the line of the longitudinal axis **42**, upon which line (or substantially close to it) is concentrated the center of mass of the enclosed beacon device **46**. Usually, with enclosed elongate devices such as the radio beacon **46**, the shock load of impact represents a shock force which, if directed along a defined axis including the center of mass of the device, presents a condition of compressive load which the device is better able to withstand than a bending moment, for example, if the shock load was presented other than along the defined axis.

The container **16**, comprised of the various parts in structural details as aforesaid, is preferably fabricated entirely of cellular polystyrene, one of the main physical characteristics of which is its extremely low density. Cellular polystyrene is primarily preferred, though, because of its fragmentation characteristic when subjected to unit stresses beyond its binding strength. Usually, this material has been thought of primarily as suitable for shipping containers or packaging material where nominally rough handling will be encountered in storing and shipping. In such a case, if unusual stresses are anticipated, the package is further enclosed in a crate, box or paperboard container in order that the package will arrive at destination intact.

In the usual case of a packaging container, fragmentation, or other breaking up of the container during packing, handling, storing and shipping, up to the time of removal of the contents, is not at all desirable, and all measures are taken to prevent just such an occurrence. Thus, it is apparent that up to the time of this invention there was no concept that fragmentation was a useful characteristic. This common concept of the characteristics of cellular polystyrene is most evident upon consideration of the military specification for the material, to wit military specification MIL–P–40619 dated April 3, 1962, which delineates governmental requirements. In that specification there is spelled out a requirement only as to compressive strength. Nothing is said as to tension, bending or shear stresses which implies strongly that not even the government had conceived novelty and utility to be had from the fragmentation characteristic of cellular polystyrene when stressed beyond its binding strength. It should be noted that MIL–P–40619 lists as one of the applicable documents, Official Classification Committee, Uniform Freight Classification Rules, from which one could draw an inference that the material should have structural integrity during its useful life.

A typical random fragmentation pattern of the container after an impact is illustrated in FIG. 6 wherein a nose segment **58** separated from the body which further fragmented into the segments **60**, **62**, and **64**. The nose segment **58** separated completely, probably upon the initial contact with the water, and it is surmised that the fragmented segments **60**, **62**, and **64** separated due to the drag of the water upon entering of the package. It should be noted that the fragmentation pattern is not at all predictable and this has been proven with a large number of test drops both on land and water. In every case the nose portion either crushed or broke away completely to uncover the chamber enclosed by the body. In all cases of drops on land, the body portion fragmented considerably to free the contained device from the container. In one case of a drop over water, the nose portion broke away from the body portion and the aft end of the body portion including most of the fins broke away from the fore-end portion. However, the contained device apparently slid through the chamber to free itself from the container and penetrated deeper into the water, after which its buoyant characteristic caused it to surface and float.

It is noted that the contained device has considerable momentum at the moment of impact, hence the device will assist greatly in breaking away the nose portion when the drop is made over water. This is because the drag force of the water upon the container exerts considerable resistance to the penetration of the package. This is aided and abetted to a large extent by the lesser weight of the container, hence the lower momentum thereof.

Typically, the package will impact substantially vertically into the water at a speed of approximately 250 knots

from an altitude of about 5,000 feet. This is not a great deal more than the package entry velocity from an aircraft flying at 400 feet with a speed of 160 knots, since at low altitude the package has both the aircraft forward velocity and the package drop velocity combined, in which case the package would enter at somewhat of an angle to the water, less than 90° from the vertical, in which case the nose portion would break off with a small portion of the body due to the small cosine function of the impact force. If the impact and entry is substantially vertical, of course, the cosine function (or laterally directed force) is substantially zero.

It should be noted that fragmentation of the nose portion invariably includes at least a small portion of the body since the cross section area of the material of the body is substantially less than that of the cross section area of the nose portion immediately adjacent the bonded joint between the two.

A typical embodiment of the invention is a container arranged to enclose a radial marker beacon device about 2¾ inches in diameter, and 38¾ inches long, having a weight of about 3½ pounds. Preferably, the container body is about 5¾ inches in outside diameter with a chamber having a bore of about 3¾ inches in diameter. The nose portion tapers forwardly from an aft end diameter of 5¾ inches to a fore end diameter of 2¾ inches in a distance of 8 inches. The overall length of the fins is 10 inches and each one extends about 4 inches from the body. The width of each of the fins is about 1¾ inches. The weighted mass in the nose portion weighs about 2 pounds. The cellular polystyrene material of which the container is comprised has a density of about 2½ pounds per cubic foot, hence the container material weighs about 1 pound. Accordingly, the container with the weighted mass in the nose weighs about 3 pounds. A container fabricated as aforesaid has been found to be very satisfactory for all requirements and has demonstrated commercial feasibility.

Appropriately configured as shown on the drawings, and dimensioned as noted above, the total projected frontal area of the four fins is very nearly equal to the projected frontal area of the body portion. This fact contributes significantly to the aerodynamic drag in free fall, hence as noted above, the nearly vertical terminal velocity of the package from a launch at 5000 feet is not much more than the terminal combined vertical and forward velocity from a launch at 400 feet.

The weighted mass in the nose moves the center of gravity forward on the longitudinal axis of the package to make the whole package nose heavy, and thus contributes considerably to rapid straightening of the free fall flight when the package is launched from a low flying aircraft.

Although the container body portion **18** has been described hereinabove as comprised of separately fabricated upper and lower body elements **26** and **28**, respectively, joined together as by cementing, it will be appreciated that the body portion can be fabricated as a single element by techniques well known in the art. Likewise, instead of fabricating the nose portion **20** separately and cementing it to the body portion **18**, the nose and body could be integrally formed, in which case the chamber **44** would be formed ab initio therein as by a mandrel disposed in the mold in which the container would be formed as a unitary structure. As aforesaid, the essential requirement for the container is that it retains its integrity up to the instant of impact, and that it fragments upon or immediately after the impact.

I claim:

1. A packaging container for a device to be impact-decelerated from a free fall comprising:

an elongate hollow chambered body portion provided with aerodynamic fins; and

a nose portion secured adjacent one end of said body portion,

said body portion being elongate substantially along a longitudinal axis thereof, the hollow chamber within said body portion being substantially symmetrical about the longitudinal axis of said body portion and opening at said one end thereof,

said nose portion serving to close off the opening at said one end of said body portion,

said body and nose portions thereby constituting an aerodynamic structure adapted substantially to stabilizing rapidly in a free fall launch with a contained device in the chamber along a line coinciding substantially with said longitudinal axis of said body portion so as to impact on said nose portion which thereupon crushes or fragments to uncover the opening at said one end of said body portion,

said body and nose portions consisting essentially of a substantially homogenenous fragmentable low density material.

2. The container of claim **1** in which the material of which it is composed is an essentially unicellular expanded polystyrene having a maximum density of about 6 pounds per cubic foot.

3. The container of claim **2** in which the density of the material of which it is composed is of the order of not more than about 2.5 pounds per cubic foot.

4. The container of claim **1** in which said aerodynamic fins are secured on said body portion adjacent the other end thereof and said fins are comprised of the same material as said body and nose portions, and the projected frontal area of said fins presented to the atmosphere in free fall of the container is approximately equal to the projected frontal area of said body portion.

5. The container of claim **1** in which the hollow chamber is of substantially cylindrical configuration and said body portion is likewise of cylindrical configuration, the projected frontal area encompassed by said body portion being at least twice that of the projected frontal area of the chamber.

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