United States Patent

Kirby

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[54] AUTOMATICALLY DEPLOYABLE SONOBUOY

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[73] Assignee: **The United States of America as represented by the Naval Air Systems Command**

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[52] **U.S. Cl.** **340/2, 9/8**

[51] **Int. Cl.** **B63b 21/52**

[58] **Field of Search** 340/2; 9/8

[56] **References Cited**

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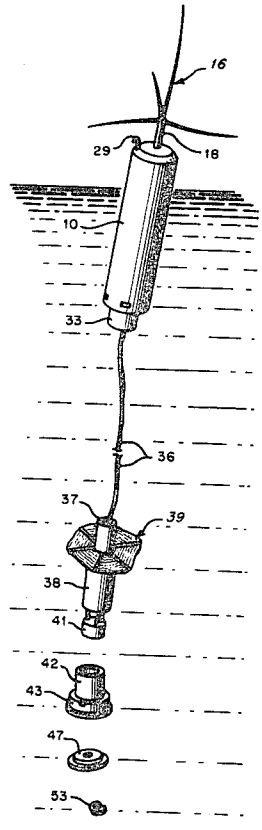
[57] **ABSTRACT**

A sonobuoy arranged to be dropped into the sea from an aircraft and automatically deployed into an operational configuration. The prelaunch configuration is generally cylindrical for ejection from a conventional airborne launching tube. After ejection, a rotochute at the upper end of the sonobuoy automatically opens to stabilize and retard descent. Upon impact with the water, the impact pressure on a movable bottom plate at the lower end of the sonobuoy forces a release rod upward along the longitudinal axis to release the rotochute. When the rotochute is jettisoned, an antenna retainer is pulled free by a lanyard attached to the rotochute thus permitting antenna and ground plane elements to erect. When the bottom plate moves inwardly a split retaining ring holding the plate is released and subsequent reduction of the impact pressure, permits a pair of leaf springs to force the bottom plate out. Cocomittantly, a hydrophone, lower electronics and compliant cable deploy from the bottom. The upper end of the sonobuoy is positively buoyant and remains at the water surface. That is, when the bottom plate falls away, the leaf springs move out of coextensive slots at the bottom of the sonobuoy housing and a hydrophone cup thereby permitting the hydrophone cup to drop off and the hydrophone and lower electronics to pay out. When the lower electronics is clear of the sonobuoy housing, an umbrellalike sea anchor opens to introduce vertical damping. A sea-activated battery slidable from the upper to lower ends of the buoy is retained in the floating portion of the sonobuoy and provides electrical power.

6 Claims, 5 Drawing Figures



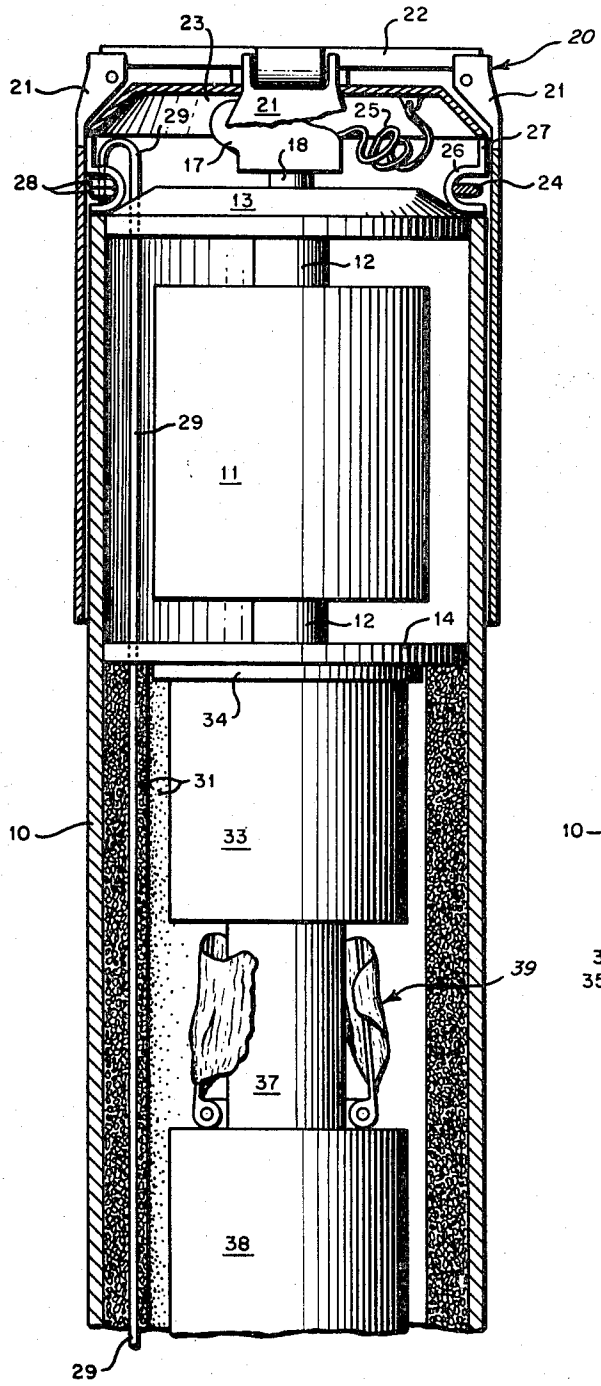


Fig. 1a

Fig. 1b

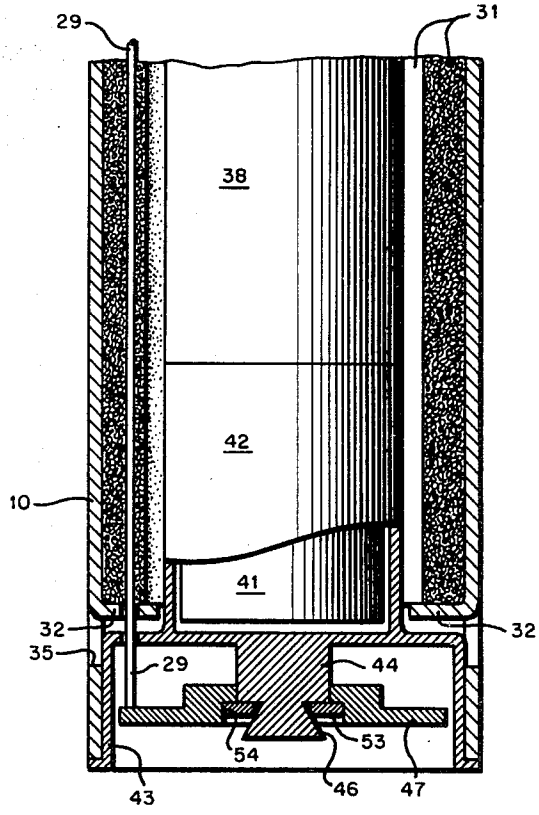


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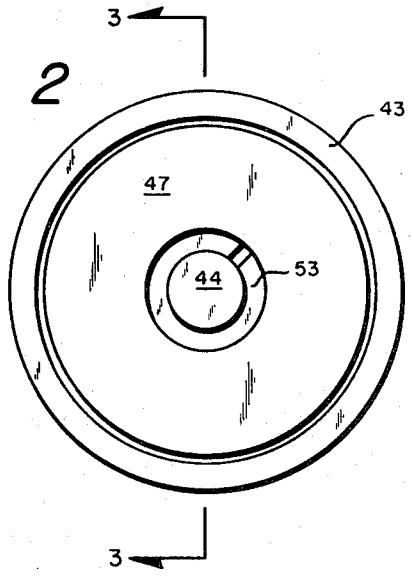
Fig. 2



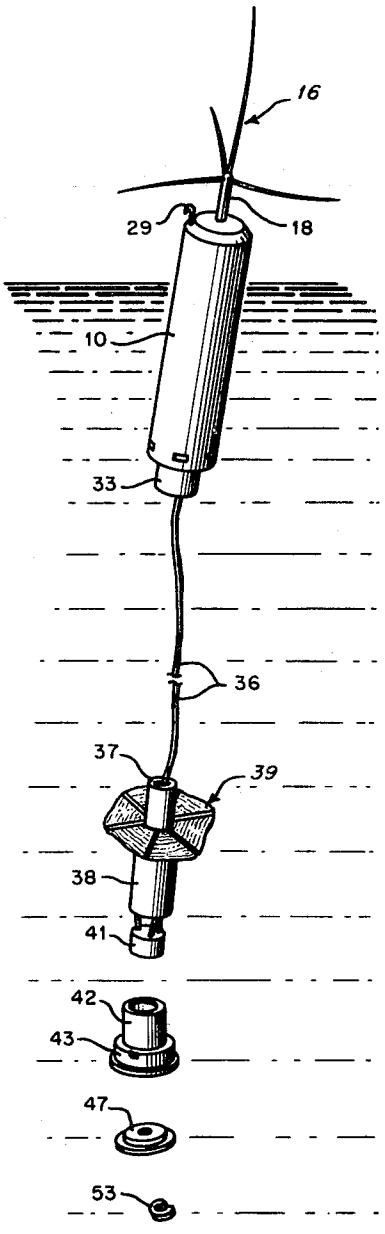


Fig. 4

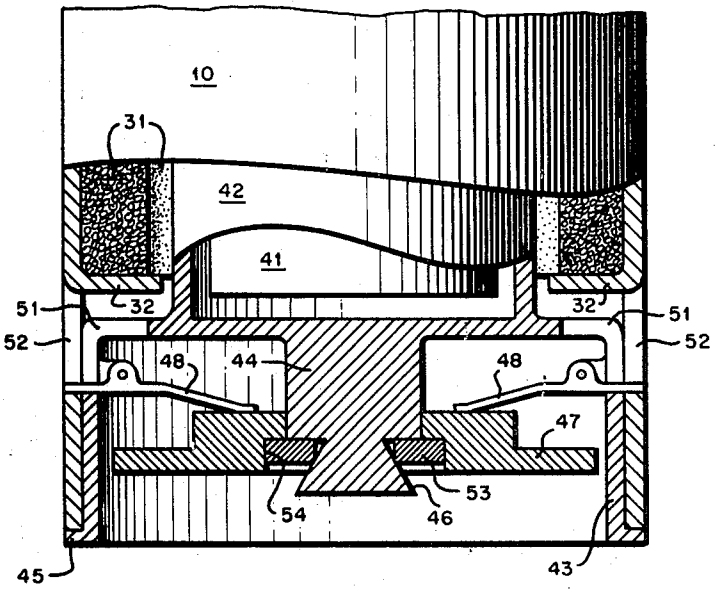


Fig. 3

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AUTOMATICALLY DEPLOYABLE SONOBUOY

STATEMENT OF GOVERNMENT INTEREST

BACKGROUND OF THE INVENTION

The present invention relates generally to underwater acoustic signal detection systems and more particularly to improvements in air-dropped, automatically deployable sonobuoys of the type wherein impact with the water causes release and pay out of a hydrophone and suspension system from a floating radio transmitter and power supply.

Efficient and reliable jettisoning or pay out of various parts of an air-dropped sonobuoy promptly after impact with the water are essential criteria for successful execution of ASW (antisubmarine warfare) operations. In its prelaunch condition, a sonobuoy is usually assembled into a cylindrical profile for ejection from an airborne launching tube. Upon ejection over an ocean area of interest, the sonobuoy configuration commences a sequence of changes in order to carry out different functions. First, a rotochute or drogue is deployed as the sonobuoy enters the slip stream of the aircraft for stabilizing and retarding its free fall. Stabilization enables precise placement of the buoy in the water and retardation minimizes the terminal velocity and water impact force. Upon entry into the water, various techniques are presently employed to further change the sonobuoy configuration into a sound detection and/or projection and radio receiving and/or transmitting system. Common to each technique are the general requirements that the stabilizing and retarding device must be jettisoned to enable unimpaired erection and operation of a radio antenna and an electroacoustic transducer must be paid out from a flotation unit to a desired listening or projecting depth. In general, such techniques have been found to be complex and expensive to manufacture, subject to premature operation during ordinary prelaunch handling or during launching, or prone to hang up of one or more elements after water entry. Occurrence of such undesirable events, of course, are logistically, economically and militarily unacceptable particularly as applied to airborne ASW operations.

SUMMARY OF THE INVENTION

Accordingly, it is a general purpose of the present invention to provide a novel and improved release mechanism for an air-dropped sonobuoy which is responsive to the impact pressure at water entry, will positively jettison stabilizing and retarding devices and ensure antenna and hydrophone deployment, and which is relatively immune to premature operation during handling, shipping, loading or launching. Another object of the invention is to provide a sonobuoy release mechanism which is relatively inexpensive to manufacture and assemble due to its simplicity of design and arrangement of parts. Other purposes and objects of the invention will become readily apparent from the detailed description of a preferred embodiment of the invention which will now be summarized as follows.

A release mechanism for an air-dropped sonobuoy which, in the prelaunch condition, defines generally an elongated cylindrical housing suitable for ejection from an airborne launching tube into the slip stream of the aircraft and having a stabilizing and retarding mechanism that is releasably secure at the upper end which deploys to an operable position when clear of the launching tube. The lower end of the housing includes an exposed bottom plate urged outwardly against a split retaining ring by respective one ends of a plurality of leaf springs pivotally connected intermediate their respective ends to a hydrophone retaining cup. The respective other ends register with slots in the lower end of the housing. A release rod extending along the length of the housing between the bottom plate and the upper end of the sonobuoy retains a hoop spring

about the interface of the stabilizing and retarding mechanism and the housing. Slight upward movement of the plate on impact at water entry causes the rod to disengage the ends of the hoop spring and jettison the stabilizing and retarding mechanism. At the same time, the split retaining ring is disengaged allowing the bottom plate to drop out of the housing. The leaf springs are then free to pivot and disengage the hydrophone retaining cup from the housing permitting the hydrophone and suspension system to pay out from the sonobuoy housing which due to its positive buoyancy remains floating at the surface.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. 1*a* and 1*b* represent upper and lower portions, respectively, in a longitudinal cutaway view of a preferred embodiment of an air-dropped sonobuoy having a release mechanism constructed according to the invention;

FIG. 2 represents a bottom view of the sonobuoy of FIG. 1*b*;

FIG. 3 represents a slightly enlarged cross-sectional view of the lower end of the sonobuoy taken along the line 3—3 of FIG. 2; and

FIG. 4 is a pictorial representation in elevation of the sonobuoy in a fully deployed condition in water.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1*a* an 1*b*, there is shown a sonobuoy according to the invention assembled in a prelaunch condition having a cylindrical housing **10**. Upper and lower bulkheads **13** and **14** form a watertight compartment at the upper end of housing **10** for containing an upper electronics unit **11** mounted on a coaxial hollow column **12**. Upper electronics unit **11** comprises a VHF transmitter whose output is connected through an insulated rod **18** telescoped inside column **12** to antenna and ground plane elements **16** (FIG. 4) adjacent to the upper surface of bulkhead **13**. The antenna and ground plane elements **16** are constructed of spring steel permitting them to be spindled within a removable antenna retainer **17**. Rod **18** is urged toward erection by spring means not shown.

A rotochute assembly **20** is releasably mounted on the upper end of housing **10** and includes four equiangularly spaced curved blades **21** (only three shown in FIG. 1*a*) hinged to a trunnion **22** which is rotatably mounted on a cap **23** for rotation about the longitudinal axis of housing **10**. Cap **23** is affixed on the top of housing **10** by a hoop spring **24** within a circumferential groove formed at the interface of cap **23** and housing **10** by respective intermeshing U-shaped tangs **26** and **27**. The ends of spring **24** have eyelets **28** which register with each other to receive the hooklike end of a stiff release rod **29** extending down along the side of the housing **10**. A lanyard **25** is connected between retainer **17** and cap **23** to cause the former to be pulled off of the spindled antenna and ground plane elements **16** when the latter is jettisoned.

To ensure positive buoyancy to housing **10**, a sleeve **31** of foamed resin lines the housing **10** between bulkhead **14** and inwardly projecting stops **32** formed in housing **10**.

Electrical power for the sonobuoy is derived from a battery package comprising a cylindrical holder **33** containing a silver-chloride cell activated by immersion in sea water. Holder **33** is slidable along the length of housing **10** and includes an annular flange **34** which is held against the outer surface of lower bulkhead **14** but engages stops **32** when holder **33** slides toward the bottom of housing **10** to improve the righting moment thereof. Housing **10** includes a plurality of openings **35** near the lower end for permitting sea water to flow freely upward past battery holder **33** to ensure a continuous supply of electrolyte.

Assembled below the battery package is a cable package comprising a single-conductor compliant cable **36** (FIG. 4) coiled in a canister **37** and electrically connects upper electronics unit **11** and the battery package at one end to a lower electronics unit **38** and hydrophone **41** at the other end. The electrical conductor of the cable is helically wound around a

compliant core to permit housing **10**, when floating, to rise and fall with a wave motion without changing the elevation of the cable at the other end. Fixed to the lower end of canister **37** is a watertight lower electronics unit **38** and an umbrellalike collapsible sea anchor **39** peripherally attached about the canister **37** at the junction with lower electronics unit **38**. Anchor **39** is constructed of fabric and stiffening rods hinged to permit folding against canister **37**. After deployment, anchor **39** opens to dampen vertical motion of the unit **38** notwithstanding motion due to waves at the surface. The lower electronics unit **38** may contain signal processing and amplifying circuits, azimuth sensore, etc., as dictated by the particular sonobuoy functions required and electroacoustic transducers utilized.

Next below lower electronics unit **38** is an electroacoustic transducer **41** slidably contained in a cylindrical cup **42**. Transducer **41** may include a plurality of piezoelectric elements, omnidirectionally and unidirectionally responsive, for sensing or projecting acoustic energy in water. In the illustrated embodiment, transducer **41** is a directional hydrophone. Transducer **41** is secured by three flexible straps to the bottom of unit **38** for acoustically isolating vibrations otherwise induced in the sonobuoy system while maintaining transducer **41** on the same azimuth as unit **38**. Cup **42** is open at its upper end to permit it to fall off of transducer **41** when released from housing **10**. The lower portion of cup **42** defines an enlarged hollow cylinder **43** whose periphery is contiguous with the inner surface of housing **10**. Cylinder **43** terminates in an annular flanged portion **45** which abuts the lower edge of housing **10** and limits the upward position of cup **42**.

Coaxially extending downward from the bottom of cup **42** is a cylindrical stud **44** terminating in an annular sawtoothlike groove **56**. The upper face of groove **46** is normal to the cylindrical axis and the lower face forms a truncated cone having its smallest diameter at the upper face. As best seen in FIGS. **2** and **3**, an annular bottom plate **47** fits loosely on stud **44** and urges the inwardly extending ends of a pair of fingerlike leaf springs upwardly. Springs **48** are pivoted intermediate their ends to diametrically opposite sides of cylinder **43**, the pivotal axes being in parallel and in a plane normal to the length of housing **10**. The other ends of springs **48** extend through openings **51** in cylinder **43** to abut the lower edges of opening **52** in housing **10**. Bottom plate **47** is prevented from moving downward with the force of springs **48** by a split retaining ring **53** whose ends are normally urged open to an inside diameter greater than the diameter at the lower end of groove **46**. The confronting ends of split ring **53**, however, are compressed together until ring **53** is positively seated in groove **46**. Ring **53** is held seated by its insertion in an annular recess **54** about the bottom edge of the opening in bottom plate **47**.

Referring again to release rod **29**, it slidably extends through bulkheads **13** and **14**, liner **31** and cylinder **43** with its lower end abutting the upper surface of bottom plate **47**.

OPERATION

The modus operandi of the above-described sonobuoy and release mechanism should be apparent and will now be summarized as follows. The sonobuoy in its generally cylindrical configuration with rotochute blades **21** retracted along the sides is launched rotochute-first from an appropriate aircraft dispenser. As the sonobuoy enters the slipstream of the aircraft, the rotochute blades open and the drag of the slipstream forces the blades to rotate. Consequently, with the blades rotating, the housing **10** swings downward and the sonobuoy autorotates to a point almost directly below the starting point of autorotation. This allows precise placement of the sonobuoy over a water area of interest. Impact with the water forces bottom plate **47** upward driving release rod **29** out of eyelets **28** of hoop spring **24**. The entire sonobuoy submerges a few feet under the surface of the water due to its original inertia and, as blades **21** strike the water, rotochute assembly **20** separates from housing **10** pulling the antenna retainer **17** free of elements **16**. Antenna and ground plane elements **16** unwind and rod **18** erects while the sonobuoy is still under water. Due to the positive buoyancy of the housing **10**, it rises to float on the surface with the antenna assembly above the surface.

At the same time when bottom plate **47** is pushed upward, retainer ring **53** extrudes from annular recess **54** and springs open to drop off of stud **44**. As the impact pressure disappears, spring **48** forces plate **47** down and off of stud **44**; the gravitational force on cup **42** pivots spring **48** out of openings **52**, and the cup **42** is permitted to drop out. Hydrophone **41**, and lower electronic unit **38** are now free to drop with cable **36** paying out from canister **37**. Battery **33** also slides to the bottom of the housing **10** until flange **34** engages stops **32**. Openings **35** in the lower end of the housing **10** adjacent to battery holder **33** insure continuous flushing of sea water in the battery cell. The final operating condition of the sonobuoy system in the water is shown in FIG. **4**.

Some of the many advantages of the present invention should now be apparent. For example, an improved sonobuoy system has been provided which affords an efficient and reliable deployment technique that can be easily manufactured and assembled with relatively few parts. The system is particularly suitable for handling without fear of premature actuation of the deployment release mechanism. The novel release mechanism is readily adaptable to many types of buoys and stores requiring rapid and sure deployment of components and materials contained therewithin.

It will be understood, of course, that various changes in the details, materials, steps, and arrangement of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

What is claimed is:

1. In a sonobuoy having an elongated positively buoyant housing, a rotochute mounted on the upper end of the housing, and an electroacoustic transducer and suspension system therefor deployable from the lower end of the housing; a release mechanism, comprising:

a first member slidably received in the lower end of the housing for retaining the transducer and suspension system therein and including a downwardly projecting stud;

a second member slidably mounted on said stud;

retaining means operatively connected between said stud and said second member for preventing downward travel of said second member on said stud; and

force-exerting means pivotally connected to said first member for simultaneously urging said second member downward against said retaining means and said first member upward against the transducer and suspension system in the housing;

whereby impact pressure at water entry of the sonobuoy sequentially releases said retaining means, first and second members and the transducer and suspension system from the housing.

2. Apparatus according to claim **1** wherein:

said stud includes an annular sawtooth groove at the distal end thereof;

said retaining means includes a split ring normally urged open to slide over said stud;

said second member includes an annular recess for receiving said retaining means when the ends of said split ring are compressed in said groove; and

said force-exerting means includes one end urged upwardly by said second member and the other end urged upwardly by the housing.

3. Apparatus according to claim **2** further comprising:

hoop spring means positioned in an annular groove formed by intermeshing edges of the rotochute and housing and having coaligned eyelets at the ends thereof; and

rod means slidable along the length of the housing having an upper end turned downward and received in said eyelets

and a lower end abutting the upper side of said second member;

whereby upward movement of said second member disengages the upper end of said rod means from said eyelets to jettison the rotochute from the housing.

4. A sonobuoy system comprising:

an elongated positively buoyant housing;

a rotochute mounted on the upper end of said housing;

an electroacoustic transducer and suspension system in said housing deployable from the lower end thereof; and

a release mechanism operatively connected to the lower end of said housing for releasing said transducer and suspension system in response to impact pressure at water entry of the sonobuoy system having a first member slidably received in the lower end of said housing for retaining the transducer and suspension system therein and including a downwardly projecting stud, a second member slidably mounted on said stud, retaining means operatively connected between said stud and said second member for preventing downward travel of said second member on said stud and force-exerting means pivotally connected to said first member for simultaneously urging said second member downwardly against said retaining means and said first member upward against said transducer and suspension system in said housing.

5. Apparatus according to claim 4 wherein said release mechanism further comprises:

said stud including an annular sawtooth groove at the distal end thereof;

said retaining means including a split ring normally urged open to slide over said stud;

said second member including an annular recess for receiving said retaining means when the ends of said split ring are pressed in said groove; and

said force-exerting means including one end urged upwardly by said second member and the other end urged upwardly by said housing.

6. Apparatus according to claim 4 further comprising:

hoop spring means positioned in an annular groove formed by intermeshing edges of said rotochute and said housing and having coaligned eyelets at the ends thereof; and

rod means slidable along the length of the housing having an upper end turned downward and received in said eyelets and a lower end abutting the upper side of said second member;

whereby upward movement of said second member disengages the upper end of said rod means from said eyelets to jettison said rotochute from said housing.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,646,505 Dated February 29, 1972

Inventor(s) Woodrow P. Kirby

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the front page, data element identifier [73], the Assignee "The United States of America as represented by the Naval Air Systems Command" should read -- The United States of America --.

Signed and sealed this 17th day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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