

TITLE OF THE INVENTION
A FOLDABLE WING STRUCTURE FOR AIRBORNE VEHICLE
OR THE LIKE

BACKGROUND OF THE INVENTION

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(a) Technical Field of the Invention

The present invention relates generally to structure of a foldable wing, and more particularly to a foldable wing structure for airborne vehicle, guided missile or the like which is kept in a canister, facilitating storage and transportation prior to launching of the same.

(b) Description of the Prior Art

Sub-sonic airborne vehicle, guided missile or the like is provided with long wingspan to increase lift and endurance, and also for easy and convenient storage and transportation before launching. Therefore, the concept of foldable wing has been widely proposed, designed and employed, for instance, in the folding wings of the Penguin and Harpoon missile. Wings of more than eight inches in length will have problems storing within the limited space of a canister or even under the aircraft deployed with these missiles. This is because an envelope of a reasonable size is required in order to be mounted onto the aircraft. In view of the above, foldable wing structure for airborne vehicle or missile is now a critical and essential feature in providing life, endurance and storage.

US Patent No. 4,411,398 issued to Larry D. Wedertz, et al discloses a retractable, self-erecting wing for a low speed missile

having a fabric wing cover affixed to a single extendable strut member for forming a wing with an internal air pocket in the extended position, and the wing cover is moveable with the strut member. The fabric wing can be completely stored within the
5 body of the missile during high speed of the missile flight and the wing is being releasable to its operative position by a latch mechanism and an actuator mounted. The disadvantage of this structure is that the retractable wing construction is applicable only for low speed missile, and it may not be applicable to missile
10 kept in a canister. The wing is retracted along with the body of the missile before deployment.

US Patent No. 4,691,880, issued to Arthur M. Frank discloses a foldable missile wing being deployed by means of an overcenter
15 linkage powered by a torsion spring assembly capable of exerting a linear bias on a linkage over its range of motion. A spring-powered system is used and the system can be tailored to match the relatively linear required hinge moment for smooth and reliable operation.

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US Patent No. 4,717,093 issued to Rosenberger et al discloses a Penguin Missile Folding Wing Configuration having an over-center locking mechanism to ensure stable, reliable and non-reversible locking of the foldable wing.

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One common disadvantage of the above-mentioned prior art is that they cannot account for wingspan of more than eight inches.

US Patent No. 5,356,094 issued to Rick Sylvain discloses a foldable, multisectional air foil with apparatus enabling it to fold or curl up or down about the body of an aircraft application.

5 The present invention overcomes problems of the above-identified prior art by providing a foldable wing structure for airborne vehicle or the like.

SUMMARY OF THE INVENTION

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Accordingly, it is an object of the present invention to provide a foldable wing structure for airborne vehicle or the like, wherein the wing has a folding capacity readily adaptable to any tube launch air vehicle system.

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Yet another object of the present invention is to provide a foldable wing structure for airborne vehicle or the like which eliminates common actuation system which is more complex and expensive.

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A further object of the present invention is to provide a foldable wing structure for airborne vehicle or the like, wherein a simple and reliable mechanism is used to cater for ease of fabrication and operation.

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It is a further object of the present invention to provide a foldable wing structure for airborne vehicle or the like, wherein the folding wings is compact and strong.

Still another object of the present invention is to provide a foldable wing structure for airborne vehicle or the like, wherein the wing structure allows a rapid deployment of wings upon launching.

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BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned objects and advantages of the present invention will be more clearly understood when considered in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic sectional view of a foldable wing structure for airborne vehicle in accordance with the present invention.

Fig. 2 is a schematic sectional view showing the extension of the foldable wing structure for airborne vehicle in accordance with the present invention.

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Fig. 3 is a perspective view showing the position of a torsion spring for the foldable wing structure in accordance with the present invention.

Fig. 4 is a perspective view of the foldable wing in a folded position in accordance with the present invention.

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Fig. 5 is a perspective view of the foldable wing in an extended position in accordance with the present invention.

Fig. 6 is a perspective view of a missile having a foldable wing structure constructed in accordance with the present invention in a folded position.

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Fig. 7 is a perspective view of a missile having a foldable wing structure constructed in accordance with the present invention in an extended position.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 is a sectional view illustrating a foldable wing structure for an airborne vehicle having its wing being folded and kept within the space of a canister before deployment. The wing 100, including a main wing 30, a mid-section wing 20, and a wing tip 10, is attached to a missile fuselage (partially shown) in a conventional way where one end of the main wing 30 is attached to the missile. As shown in the figure, one end of the mid-section wing 20 is pivotally connected with the free end of the main wing 30 at an angle approximately 60 degree away from the axial of the main wing 30, wherein a torsion spring 8 is mounted between the connecting joint of two ends thereof. One end of the wing tip 10 is torsionally connected to the other end of the mid-section wing 20 with a torsional spring 9 such that the wing tip 10 and the mid-section wing 20 are pivotally connected. The remote end of the wing tip 10 is provided with a notch 102 for the engagement with a locking mechanism 60. In accordance with the present

invention, the free end of the wing tip 10 is releasably locked to the main wing 30 of the wing structure 100 by means of a hook 62, so that the entire wing structure 100 is securely folded before deployment. The hook 62 is a component of the locking
5 mechanism 60, and the locking mechanism 60 further includes a pivot joint 50, an actuating rod 40, and a spring 46. The hook 62 is rotatably secured on the main wing 30 about a pivot 64 positioned on the main wing 30. The pivot joint 50 is hinged at one end of the actuating rod 40. The hook 62 is protruded above the surface of
10 the main wing 30 so that the hook 62 can be engaged with the notch 102 provided at the edge at the end of the wing tip 10. The actuating rod 40 is free to slide through a support 7 located at the remote end of the main wing 30, and the spring 46 is positioned around the actuating rod 40.

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As shown in Figs. 1 and 4, before the wing structure 100 is deployed, the actuating rod 40 keeps the locking mechanism 60 in place and tensions the spring 46. Referring again to Fig. 1, the free end of the actuating rod 40 passes through the edge surface of the
20 remote end of the main wing 30 to touch the interior wall of the canister 200. In accordance with the present invention the arrangement of the wing structure 100 with respect to the canister 200 enables the airborne vehicle, or missile to be kept with folded wing in the canister 200, as shown in Fig. 6.

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Fig. 2 shows the extended position of the wing structure 100 in accordance with the present invention. Upon launching the airborne vehicle or the missile, once it leaves the canister 200, the actuating rod 40 ejects out due to the mechanical energy stored in

the spring 46 and in the course of ejection of the actuating rod 40, the hook 62 of the locking mechanism 6 rotates about the pivot 64 in an anti-clockwise direction as shown in Fig. 2. This movement of the hook 62 will unlock the wing tip 10 and in turn, the torsion springs 8 and 9 as shown in Fig. 1, unfold the wing tip 10 and the mid-section wing 20 automatically. A perspective view of a fully extended wing structure 100 is shown in Fig. 5 and Fig .7 of the present application.

10 When the wing structure 100 is fully extended from its folded position, the wing tip 10 and mid-section wing 20 are deployed as shown in Fig. 5. In accordance with the present invention, the connection joints between the end of the wing tip 10 and one end of the mid-section wing 20 is shown in Fig. 3.

15 Referring to Fig. 3, the end of the torsion spring 8 is located at the center of the edge of the end of the main wing 30 and the end has a substantially E-shaped structure. Latches 101 are provided at appropriate position at the E-shaped structure so as to
20 secure onto apertures 15 provided on fingers 118 located at the end of the mid-section wing 20. A mounting rod 14 connects the remote end of the main wing 30 and the fingers 118 of the mid-section wing 20 via holes provided thereto. Thus, the mid-section wing 20 is foldable against the free end of the main wing 10 at an
25 angle of appropriate 60. A step 11 and a stopper 12 are provided on the edge of the notches 14 formed on the free end of the main wing 30 so that when the wings 10 and 20 are fully deployed, the stopper 12 and the step 11 will act as a blocking device as well as for alignment of the wings 10, 20, 30. As shown in the figure, the

tip of the rod 40 is inserted into a cylindrical hole 16 at the side of the end of the mid-section wing 20. The cylindrical hole 16 is in alignment with the rod 40.

5 Fig. 4 illustrates a perspective view of the wing structure of the present invention in its folded position or stowed position. Fig. 5 illustrates a simplified perspective view of the wings in deployed position.

10 Fig. 7 illustrates a missile having a cylindrical body with circumferentially spaced wing structure in extended position. Fig. 6 illustrates a missile having a cylindrical body with circumferentially spaced wing structure in a folded position. As only for illustration, in both diagrams, four wing structures 100
15 are shown. It is understood that any suitable number of the wing structure 100 can be used. The wing structures 100 of the missile are identical

20 While this invention has been described in terms of a specific preferred embodiment, it is contemplated that various alterations and modification thereof will become apparent to those skilled in the art. It is therefore intended that the appended claims included all such alterations and modifications as fall within the true spirit and scope of the present invention.

CLAIMS

1. A foldable wing structure for airborne vehicle or the like having
5 a main wing, a mid-section wing, and a wing tip characterized
in that one end of the main wing is mounted onto the airborne
vehicle and one free end of the main wing is pivotally
connected to one end of the mid-section wing, the other end of
the mid-section wing is pivotally mounted with one end of the
10 wing tip, a torsion spring is provided to each of the connection
joint between the ends, and a locking device is mounted within
the main wing, such that the releasing of the locking device
causes the wings to be extended.
- 15 2. The foldable wing structure of claim 1, wherein the mid-section
wing is at appropriate 60 degree away from the main wing
when the wing is folded.
3. The foldable wing structure of claim 1, wherein the locking
20 device mounted within the main wing comprises a hook
engaged with the wing tip, an actuating rod having one end
hinged connected to one end of the hook, and a spring enclosed
the actuating rod such that the extension of the actuating rod
releases the engagement of the wing tip.
- 25 4. The foldable wing structure of claim 1 or 3, wherein the free
end of the actuating rod touches the inner wall of the canister
when the airborne vehicle is kept within the canister.



5. The foldable wing structure of claim 1 or 3, wherein the free end of the rod is inserted into a cylindrical hole provided at the end of the mid-section wing when the wing structure is deployed or in an extended position.

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6. The foldable wing structure of claim 3, wherein the hook is in engagement with a notch provided at one end of the wing tip.

7. The foldable wing structure of claim 1, wherein latches and steps are located on edge of the notch of end of the main wing which locked the mid-section wing in place in the course of deployment.

8. The foldable wing structure of claim 1, wherein a torsion spring is provided to the connection joint between the main wing and the mid-section wing, and the joint between the mid-section wing and the wing tip, the torsion spring retracts the respective wing section during deployment.

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