# United States Patent

**Watson**

[15] **3,697,019**

[45] **Oct. 10, 1972**


[54] **STABILIZING FIN ASSEMBLY**


[72] Inventor: **James K. Watson,** Potomac, Md.

[73] Assignee: **The United States of America as represented by the Secretary of the Navy**



[22] Filed: **May 13, 1970**

[21] Appl. No.: **36,830**

[52] **U.S. Cl.** ..... **244/3.29**

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

[58] **Field of Search** ..... 244/3.29



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,278,830 | 9/1918 | Becker | 244/3.29 |
| 3,031,967 | 5/1962 | Jasse | 244/3.29 |
| 3,177,809 | 4/1965 | Russell-French | 244/3.29 |



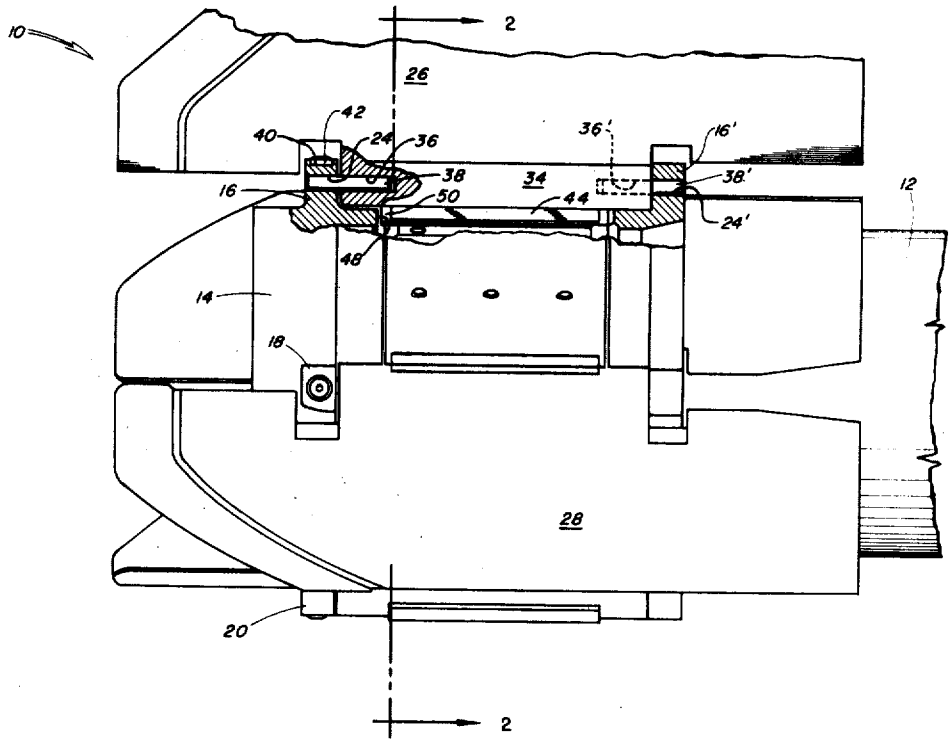
*Primary Examiner*—Verlin R. Pendegrass
*Attorney*—R. S. Sciascia and J. A. Cooke



[57] **ABSTRACT**

A fin assembly for stabilizing aerial vehicles having a plurality of curved fins pivotally connected to a shroud on the vehicle for pivotal movement from a folded position to an erected position about axes parallel to the direction of flight of the vehicle. Each fin is locked in its erected position by a latch mechanism which includes a locking lug on the fin and a slot in the shroud to receive both the lug and a lug locking wedge which prevents movement of the fin in any direction from its erected position.


**6 Claims, 2 Drawing Figures**



PATENTED OCT 10 1972

3,697,019

SHEET 1 OF 2

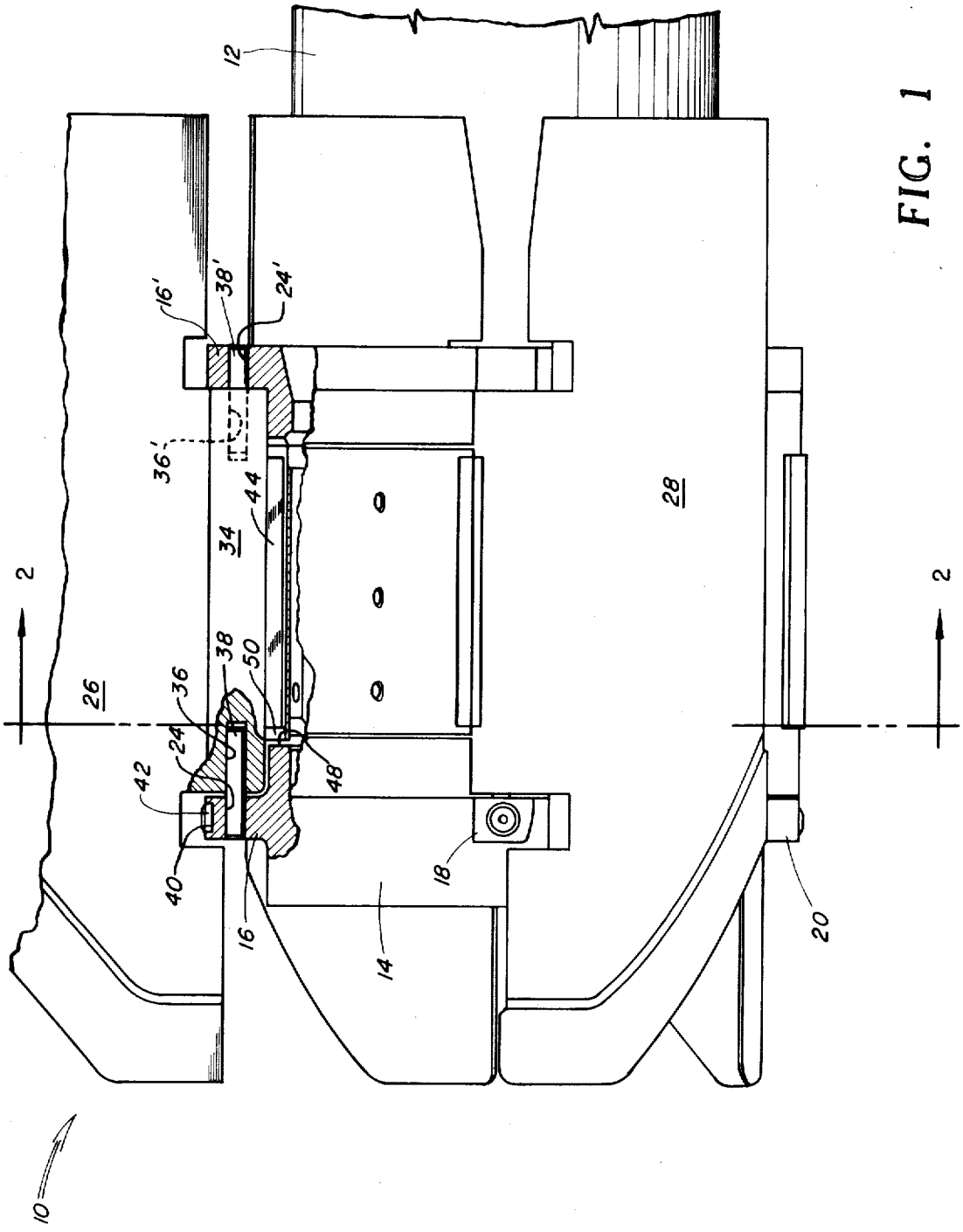



FIG. 1

INVENTOR
James K. Watson

BY

J.O. Tresansky
R.J. Erickson

ATTORNEYS

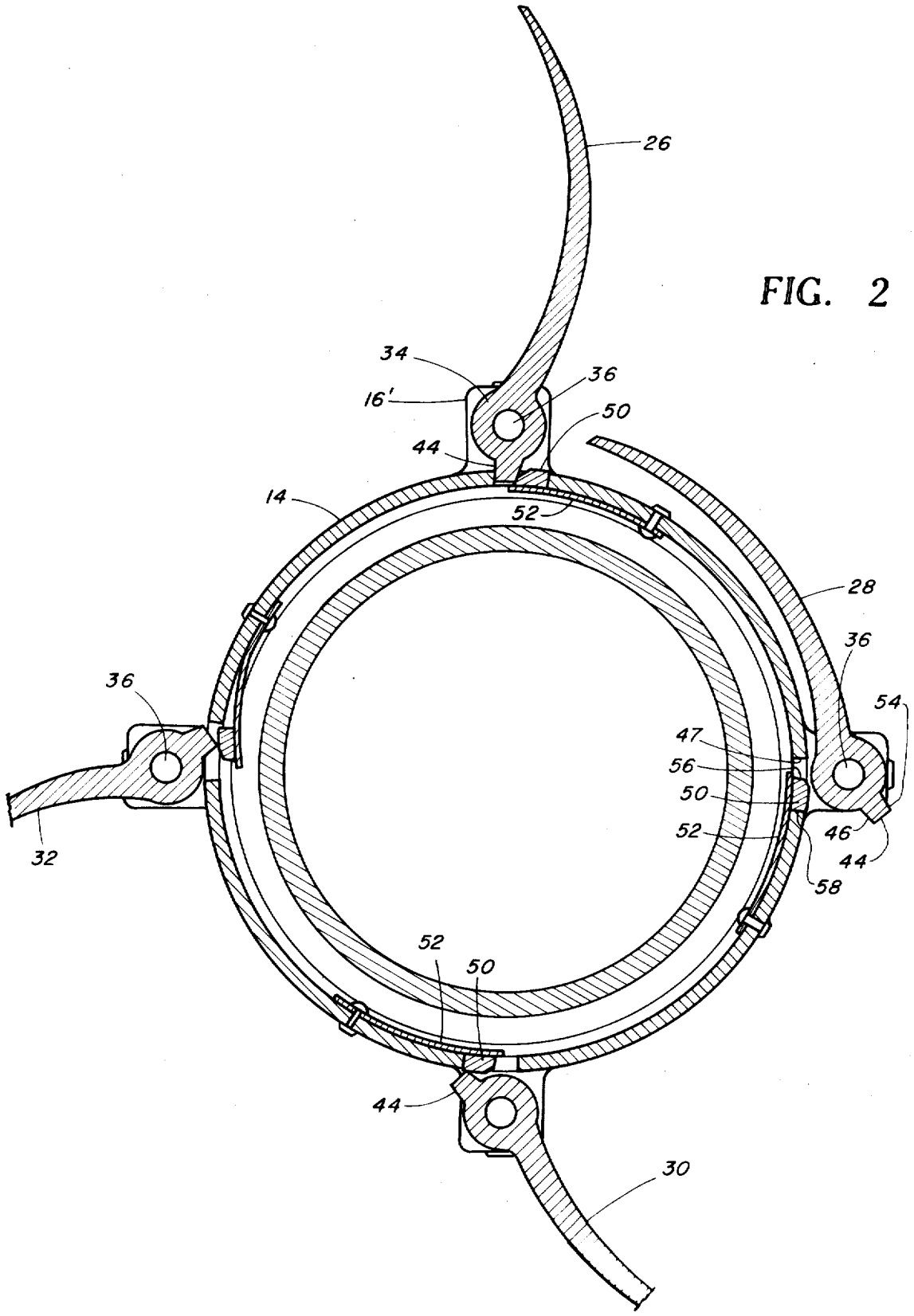



FIG. 2

# STABILIZING FIN ASSEMBLY

## BACKGROUND OF THE INVENTION

The invention relates generally to aerial vehicle stabilizing fins and more particularly to a folding fin assembly for stabilizing aerial vehicles especially at hypervelocities.

Folding fins have been used on aerial vehicles, such as missiles, to conserve storage space and to minimize handling problems, the fins having been erected to their operative positions prior to placement on a launching device. In other instances, aerial vehicles, such as missiles, adapted to be fired from launching tubes have been equipped with folding fins to reduce the profile of the vehicle in the tube. These latter fins are opened to their operative position by springs or centrifugal force when the vehicle clears the launching tube. Although these folding fin assemblies have operated satisfactorily in most applications, the diameter of such fin assemblies is usually substantially greater than the diameter of the missiles on which they were mounted, even when the fins are folded, thus necessitating the use of launching tubes considerably larger than the missiles.

Although some previous folding fin assemblies included latch mechanisms for holding the fins in their erected position after launch, it has been found that the latch mechanisms add considerable bulk and weight to the missile and can not withstand the aerodynamic forces encountered by hypervelocity missiles. With the recent development of improved aerial vehicles and particularly hypervelocity missiles, a requirement has arisen from an improved folding fin and latch mechanism capable of withstanding the large aerodynamic forces encountered in a hypervelocity environment.

## SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a folding fin assembly having a new and improved latch mechanism.

Another object of this invention is to provide a compact high-strength folding fin and latch mechanism assembly.

Still another object of this invention is to provide an improved stabilizing fin assembly for either spin launched or non-spin launched missiles.

A further object of the invention is to provide a high-strength folding fin and latch mechanism assembly for aerial vehicles having the characteristics of minimum weight and size capable of withstanding aerodynamic loads encountered in a hypervelocity environment.

To attain these and other objectives, the present invention contemplates a stabilizing assembly adapted to be secured to an aerial vehicle and having a plurality of fins which in a folded position conformingly encircle the associated vehicle and which are movable from their folded position to an open position wherein the fins project radially outwardly and are positively restrained from movement in either direction.

## BRIEF DESCRIPTION OF DRAWINGS

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:



FIG. 1 is a side elevation partially in section of the fin assembly on the aft end of a missile; and

FIG. 2 is a transverse cross-sectional view showing the four fins of the assembly in varying stages of movement from their fully folded position to their fully opened position.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference numerals designate like parts throughout the several views, and more particularly to FIG. 1 the folding fin assembly indicated generally by numeral **10** is shown as mounted on the aft portion of a missile **12**. The folding fin assembly includes a cylindrical shroud **14** adapted to be mounted upon the aft portion of a missile by any suitable connecting means, not shown, and includes two longitudinally spaced rows of outwardly extending radial projections defining four pairs of aligned projections **16, 18, 20** and **22** symmetrically positioned about the periphery of the shroud, as more clearly shown in FIG. 2. Each pair of projections has aligned through-apertures formed therein along axes parallel to the longidutinal axis of the missile, as represented by apertures **24** and **24'** in projections **16** and **16'** respectively. The four pairs of outwardly extending shroud projections function as pivotal support members for each of four fins **26, 28, 30** and **32** respectively.

Each fin includes an aerodynamic vane portion, which is curved to conform to the profile of the shroud **14** when the fin is in its folded position for the purpose of conserving space within the launching tube and which extends radially outwardly from the shroud when the fin has been moved from its folded position to an open or erected position to stabilize the missile flight, and further includes a reinforced base portion **34** which projects downwardly from the vane portion. Preferably, the length of the base portions **34** is approximately equal to the distance between the pairs of shroud projections to provide an interleaved mating coupling with the shroud projections. Base portion **34** of each fin has formed therein a pair of oppositely disposed aligned bores **36** and **36'** in axial alignment with the through-apertures **24** and **24'** to receive a pair of hinge pins **38** and **38'** to hingedly connect each fin to the shroud for pivotal movement about an axis parallel to the longitudinal axis of the missile.

When the stabilizing fin assembly of this invention is used on missiles of the type which do not spin during launch, the fins may be automatically moved from their folded position to their open position after launch by suitable springs, not shown, by aerodynamic forces acting on the fins, or by other suitable means, not shown. When the stabilizing fin assembly of this invention is used on missiles which are subjected to rotational spin about their longitudinal axis during launch, it is convenient to utilize the centrifugal force developed during launch to move the fins from their folded position to their open position. For this purpose, the rearward-most row of shroud projections **16, 18, 20** and **22** may be provided with recesses **40** to partially receive bourrelet pellets **42** which are adapted to engage the internal rifling grooves in a launching tube when the fins are

folded. Engagement of the bourrelet pellets 42 with the rifling in a launching tube imparts rotational spin to the missile about its longitudinal axis upon launching thereby to develop centrifugal forces which act upon the fins 26, 28, 30 and 32 to pivot them about their hinge pins 38 from their closed position as shown by fin 28 in FIG. 2 to their fully opened position as shown by fin 26 in FIG. 2. As the missile travels through the launching tube, pivotal movement of the fins is constrained by the walls of the launching tube but, immediately upon leaving the muzzle end of the launching tube, all four of the fins are simultaneously opened by the centrifugal force. To arrest the pivotal movement of the fins and hold the fins in their erected position, each fin is provided with an elongate lug 44 having an impact surface 46 which engages an impact surface 47 on the shroud defined by an elongate lug-receiving slot 48 formed in the shroud 14. To hold the fins in their erected position, each of the elongate lug-receiving slots is provided with an elongate locking wedge 50 secured by any suitable means to the free end of a cantilevered leaf spring 52 which is secured to the shroud 14 at one end by welding, rivets, or any suitable means.

A latch mechanism of optimum strength is provided by making the slots 48, lugs 44 and wedges 50 of sufficient lengths to extend through most of the axial distance between the shroud projections, as shown in FIG. 1. This design provides large impact surfaces 46 and 47 on the lugs and slots, respectively, and provides large areas for contact between the locking wedges and lugs to effectively retain the fins in their erected position. The lugs and locking wedges are also designed so that their combined cross-sections within the slots substantially fills the area of the slots and reduces to a minimum any clearance between the lugs and wedges, thus eliminating possible vibration of the lugs in the slots. Minimum clearance between the lugs and locking wedges may preferably be attained by providing the lugs 44 and wedges 50 with cooperating slanted surfaces 54 and 56, respectively, which are substantially coplanar, as shown by FIG. 2. It may also be desireable to make surface 58 of the wedge substantially parallel to its opposed surface 56 to reduce the clearance between wedge surface 58 and the edge of the slot on which it seats.

The operation of the preferred embodiment of this invention may be better understood by reference to FIG. 2 which shows the movement of the fins from their folded to opened positions. Prior to launch, all fins are fully folded in the position of fin 28 and the locking wedges 50 are held within the lug-receiving slots 48 by leaf springs 52. Upon firing of the missile, the bourrelet pellets engage the rifling in the launching tube and impart rotational spin to the missile about its longitudinal axis. As soon as the missile clears the launching tube, the centrifugal force on the fins causes all of the fins to open simultaneously. During initial pivotal movement of the fins, the bottom of each of lugs 44 is rotated into contact with the top of each of locking wedges 50, as shown by the position of fin 30. Further pivotal movement of the fins causes the lugs 44 to depress the wedges 50 against action of the leaf springs 52 developing a restoring force in springs 52, as shown by the position of fin 32. When the fins have pivoted to their fully opened position, as shown by the position of fin 26, the impact surface 46 of the locking lugs 44 engages the impact surface 47 of the slots 48 to stop further rotation of the fin. In this position, the bottom of the locking lug 44 is no longer in contact with the wedges 50 and therefore the restoring force developed by deflection of the springs 52 forces the locking wedges back into the slots 48 to firmly hold the locking lugs in the slots.

Stabilizing fins on missiles travelling at hypervelocity speeds experience positive aerodynamic loads first on one lateral side of the fin vane during a first range of velocities and experience positive aerodynamic loads on the opposite surface at a higher range of velocities, for which reason it is necessary to positively lock the fin against movement in both the clockwise and counterclockwise directions.

From the foregoing, it will be appreciated that the present invention accomplishes this most effectively because aerodynamic loads on either side of the fin vanes will be distributed over large surface areas and will be resisted by reaction forces taken upon compression. Additionally since all components are easily designed to have high yield strengths in compression, the device of this invention has great shear strength and torsional rigidity during hypervelocity flight even at angles of attack differing from zero. Although aerodynamic loads tending to rotate the fins in a counterclockwise direction create compressive forces upon the wedges having a small component of force which would tend to deflect the wedges downwardly out of the slots 48, such displacement of the wedges does not in fact occur because the static friction developed between the side walls of the wedges and the walls of the lugs and the slots is of sufficient magnitude to prevent displacement of the wedges from the slots. The present invention therefore provides a folding fin and latch mechanism assembly of compact design, minimum weight, and optimum strength to withstand the large aerodynamic loads encountered in a hypervelocity environment.

Obviously numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A folding fin stabilizing assembly for an aerial vehicle comprising:

fin support means symmetrically spaced and mounted externally about the periphery of an aerial vehicle,

a plurality of fins each having a vane portion and a base portion,

said vane portion having a configuration substantially conforming to a portion of the vehicle when said fins are in a folded position,

said base portion having a locking lug extending therefrom in a direction opposite to the vane portion,

hinge means for pivotally connecting said fins at their base portions to said support means for rotational movement from a folded position to an opened position,

lug capturing means including means defining a plurality of elongate rectangular slots in said fin support means having a length slightly greater than the length of said lugs and a width substantially greater than the width of said lugs each for receiving one of said lugs when said fins are in an open position,

a plurality of lug latching wedges each mounted on said fin support means and movable in one of said elongate slots for locking engagement with one of said lugs to thereby lock and restrain said fins from further rotation from said open position, and

means for resiliently biasing said wedges into a position within said slots.

2. The device of claim 1 wherein said resilient biasing means comprises

a plurality of leaf springs each having one end fixedly secured to the interior of said fin support means and having one of said wedges mounted on its other end.

3. The device of claim 2 wherein,

each of said locking lugs has an impact surface formed thereon which lies in a plane substantially parallel to a plane passing through the diameter of the vehicle for engagement with coplanar impact surface defined by said slot,

each of said lugs having a wedge-engaging surface which lies in a plane which intersects a diameter of the vehicle,

said wedge having a flat lug engaging surface substantially coplanar with said wedge-engaging surface of said lug.

4. The device of claim 3 wherein,

said fin support means includes an annular shroud adapted to be mounted externally on the vehicle,

said hinge means includes a plurality of pairs of outwardly extending longitudinally spaced projections formed on said shroud,

the base portion of said fins projecting downwardly from the vane portions of said fins,

said projections on said fins and said shroud being inter-leaved and pivotally connected together by hinge pins for rotation of said fins about axes parallel to the longitudinal axis of the shroud.

5. The device of claim 4 further comprising

means formed on said shroud extensions for operative engagement with rifling grooves in the interior of a lauching tube.

6. The device of claim 5 wherein said rifling engaging means comprises

bourrelet pellets fixedly secured to the ends of said shroud projections and extending radially outwardly therefrom beyond all other parts of the assembly when the fins are in their folded position.

* * * * *