Sept. 17, 1963 C. H. POPENOE 3,103,886

COILING FIN FOR TUBE LAUNCHED MISSILES

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FIG. 1.

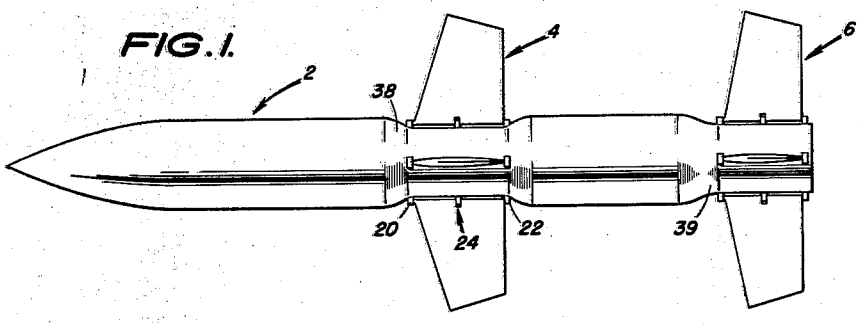
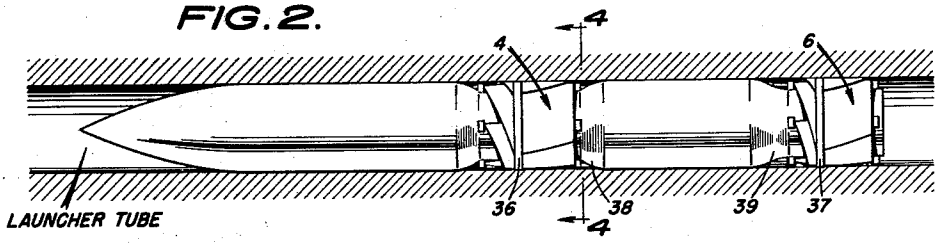


FIG. 2.



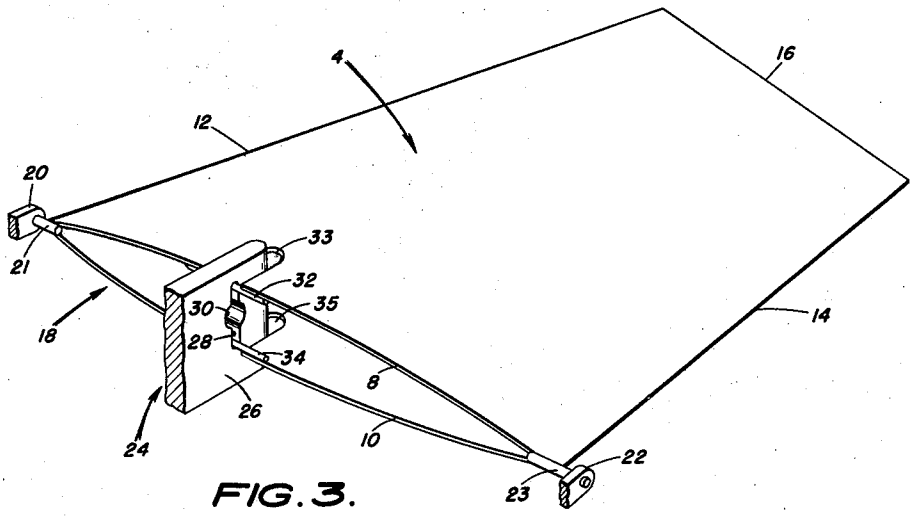


FIG. 3.

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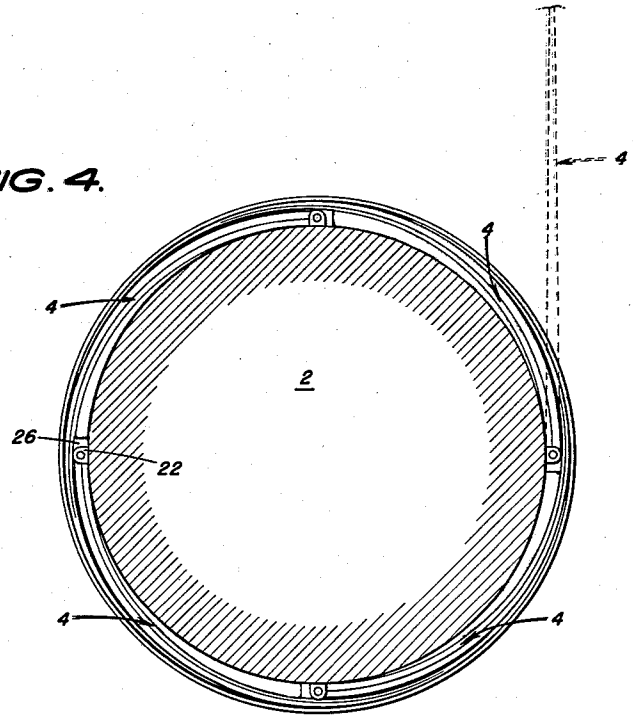
FIG. 4.



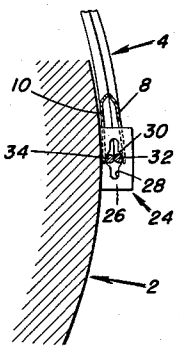


FIG. 5.

FIG. 6.

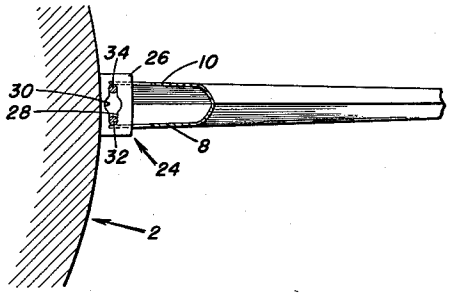


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FIG. 7.

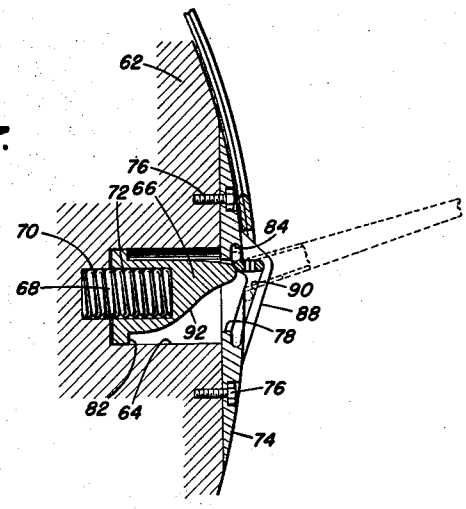
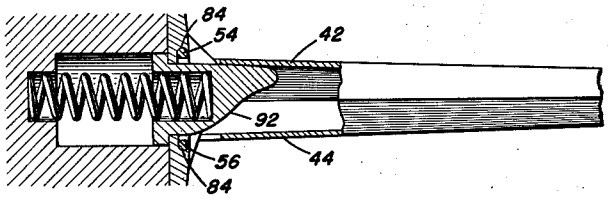


FIG. 8.



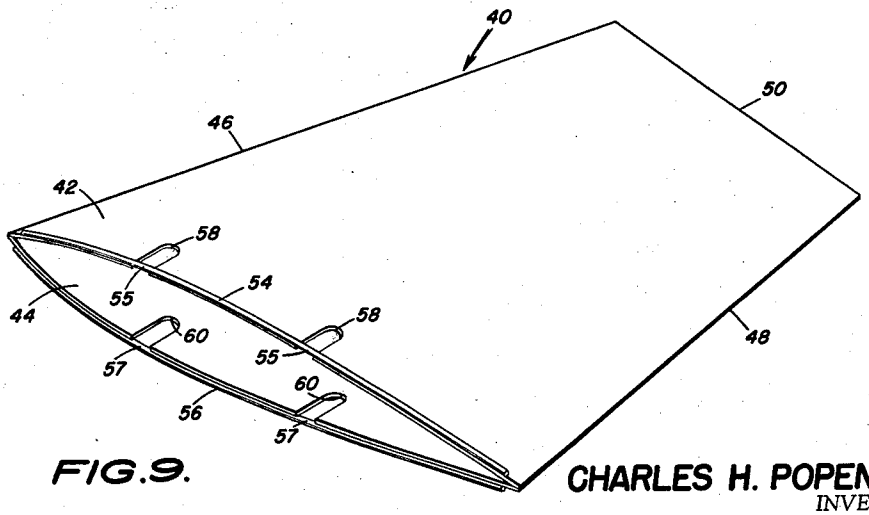


FIG. 9.

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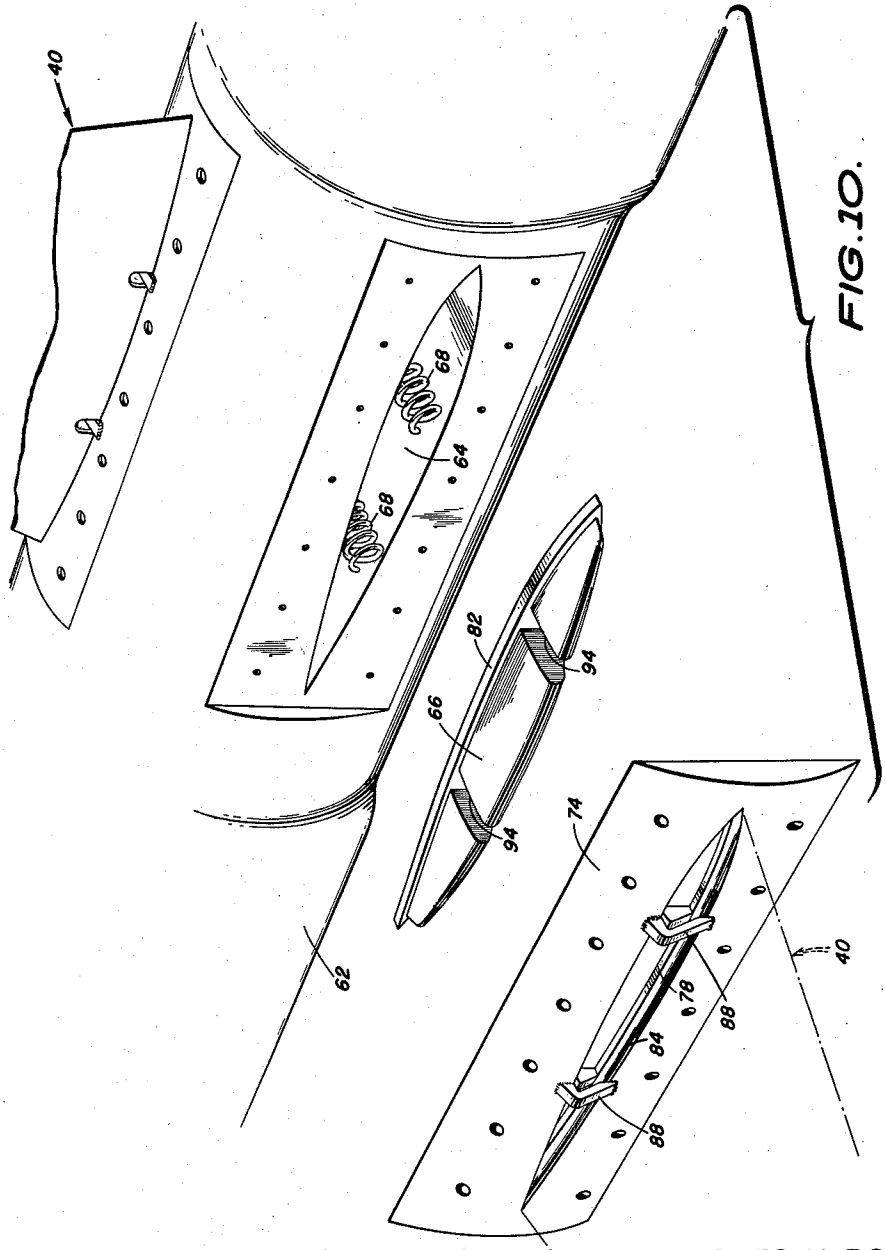

FIG. 10.

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3,103,886

COILING FIN FOR TUBE LAUNCHED MISSILES

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Filed Oct. 13, 1960, Ser. No. 62,514
2 Claims. (Cl. 102—50)

This invention relates generally to missile fin structure; more particularly, it relates to a flexible fin for use on missiles designed for launching from tubular launchers.

A common method of launching missiles, especially those of small caliber, is by employing a tubular launcher. Light weight tubular launchers may be employed for shoulder-launched missiles of the bazooka type, as well as for aircraft and light ground vehicle launched weapons. One of the principal problems associated with such tube-launched missiles has been to provide fin surfaces adequate to aerodynamically stabilize the missile during flight, and yet provide a means to allow folding or retraction of such surfaces into the missile, so that it may be fitted into a launching tube.

The primary object of this invention is to provide a low-cost, relatively simple fin for fulfilling the stabilization and aerodynamic control requirements of tube-launched missiles, consisting of flexible fin surfaces having areas sufficient for purposes of assuring missile stability when erected, said surfaces being movable to positions lying about the missile in retracted positions.

Another object of the invention is to provide a flexible fin for tube-launched missiles, said fin being so constructed as to be self-erecting after the missile has been launched.

It is also an object of the invention to provide a flexible fin for tube-launched missiles that is so constructed as to become substantially rigid upon erection thereof.

A further object of the invention is to provide a locking device for a flexible fin, said device being so constructed as to cooperate with said fin to maintain the same in an erect position.

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 of a missile, showing a plurality of fins in erected, in-flight, positions;

FIG. 2 is a view in elevation of a missile positioned in a launching tube, with its fins retracted and wrapped about the mid-portion and aft end of said missile;

FIG. 3 is an enlarged, perspective view of one of the fins;

FIG. 4 is a cross-section, on an enlarged scale, on line 4—4 of FIG. 2;

FIG. 5 is a detail sectional view, showing the root end of a fin in its retracted, wrapped position;

FIG. 6 is a fragmentary sectional view, similar to FIG. 5, but showing the fin portion in its erected position;

FIG. 7 is a detail sectional view, showing a portion of a modified form of fin in wrapped position;

FIG. 8 is a detail sectional view, showing the modified fin of FIG. 7 in erected position;

FIG. 9 is an enlarged, perspective view of the modified fin of FIG. 7; and

FIG. 10 is an exploded perspective view of the modified fin construction of FIG. 7.

Missiles of the type here involved are normally small caliber rocket missiles of the bazooka type. Such a missile is shown at 2 in FIG. 1, as it would appear when in flight. The missile 2 has a plurality of forward fins

4 and aft fins 6 thereon, each of which is constructed and secured to the missile in the same manner.

The flexible fin of the present invention may be wrapped around the adjacent outside circumference of the body of a missile in retracted position, but will become quite rigid when in an erect position. The construction of one of the fins 4 of the invention is shown in FIG. 3, wherein said fin is seen to be fabricated of two pieces of thin gauge, resilient material, such as spring steel, one piece each for the top and bottom surfaces 8 and 10, respectively. These pieces or sheets are preformed into arcuate cross-section, much like metallic Venetian blind slats, and are placed together with their concave surfaces facing each other, and are then secured to one another, as by a seam weld, at the leading, trailing and tip edges 12, 14 and 16, respectively.

The fins are each attached at their root ends to the body of a missile, in a manner that allows the upper and lower surfaces or sheets of the fin to be flexed toward each other. Referring again to FIG. 3, the fin 4 is attached at its root end 18 to a forward hinge plate 20 and an aft hinge plate 22, said hinge plates being attached to the body of said missile. A forward hinge pin 21 is attached to the fin near the leading edge of the root end 18 thereof, and is slidably and rotatably received within the hinge plate 20. Similarly, an aft hinge pin 23 is attached to the fin 4 at its trailing edge, and is slidably and rotatably received in the hinge plate 22. Midway between the hinge plates 20 and 22 a wing locking device 24 is provided. The device consists of a missile mounted control member 26 which has near its outer edge an elongated vertical slot 28. The center of the slot 28 is enlarged at 30 to a diameter sufficient to accommodate two pivot pins 32 and 34, which pins are suitably secured to the central portions of the root end edges of the fin surfaces 8 and 10, respectively. While the pivot pins are shown secured to the interior of the fin surfaces, it is to be understood that instead they could be secured to the exterior thereof. The surfaces 8 and 10 have vertically aligned, oblong notches 33 and 35, respectively, therein of a size sufficient to freely accommodate the outer end portion of the control member 26.

When the root end 18 of the fin 4 is secured to the missile in the fin-erect condition, with the surfaces 8 and 10 separated at their inner ends, as shown in FIGS. 3 and 6, the resultant airfoil structure is quite rigid; however, if the surfaces 8 and 10 are squeezed together, as shown in FIGS. 4 and 5, the fin becomes sufficiently flexible to permit it to be wrapped around a missile section having a comparatively small radius.

The fin wrapping operation is effected as follows. The inner end portions of the fin surfaces 8 and 10 are manually squeezed toward each other until the pivot pins 32 and 34 engage, at which point the fin may be rotated 90° to a position at which its plane will be tangent to the missile, as is indicated by broken lines in FIG. 4. The notches 33 and 35 must be of sufficient depth to allow such rotation. The enlargement 30 of slot 28 will now receive the pins 32 and 34 and maintain the inner end portions of the surfaces 8 and 10 in a squeezed-together, closed condition, and the fin may be wrapped partially about the missile body. As is shown in FIG. 4, the fins may be of such length that the outer end portions of one will overlie the inner end portion of the adjacent fin about the missile body.

The fins 4 and 6 are shown in FIG. 2 of the drawing to be held in the wrapped condition by bands 36 and 37, respectively. A device (not shown) is incorporated to release the bands after the missile has been launched, thus releasing the wrapped fins. Where the fins might be

subject to damage during handling and transit, the bands 36 and 37 can be made of sufficient width to cover completely the wrapped fins. Further, in some applications the bands could be eliminated entirely, and the fins held in a wrapped condition by the launcher tube only.

As best seen in FIGS. 1 and 2, shallow circumferential recesses 38 and 39 are provided in the missile body in the area of the fins 4 and 6 in order that said fins when wrapped, will lie with their outer surfaces flush with the missile body surfaces. The volume required to store the wrapped fins is quite small, and after the fins have been erected, the recesses will have an area ruling effect, when properly faired, to lower transonic drag.

Upon release of the bands 36 and 37 after missile launch, the fins first tend to straighten themselves. The momentum built up in this operation moves the fin 4 until it is perpendicular to the missile surface, at which point the surfaces 8 and 10 pull away from each other, such action being caused by their resilient nature. The pins 32 and 34 will then move to opposite ends of the slot 28, and the fin will be locked in place in an erect, substantially rigid position.

A modified form of wraparound fin is shown in FIGS. 7, 8, 9 and 10. Referring to FIG. 9, a fin is indicated generally at 40, the fin having a top surface 42 and a bottom surface 44, these surfaces being similar to the surfaces 8 and 10 shown in FIG. 3. The surfaces 42 and 44 are secured to one another at their leading, trailing and tip edges 46, 48 and 50, respectively.

The root end of the fin has a pair of retainers 54 and 56 thereon, the retainer 54 being attached to the top surface 42 and the retainer 56 to the bottom surface 44. The retainers 54 and 56 consist of pieces of resilient wire secured in position, as by welding, and extend almost the full width of the fin. The surfaces 42 and 44 have pairs of laterally spaced, vertically aligned notches 58 and 60 therein, said notches being similar to the notches 33 and 35 in the fin construction of FIG. 3.

A portion of a missile is shown in cross-section at 62 in FIGS. 7 and 8, and in perspective in FIG. 10. The missile has a plurality of recesses therein, one for each fin. One such recess is shown at 64. The recess 64 is shaped to generally correspond to the cross-sectional configuration of the inner end of an erected fin, and has an oblong faired locking plug 66 disposed therein. Spaced springs 68, each of which has its inner end seated in a socket 70 within the recess 64 and its outer end in a socket 72 in the plug 66, are employed to urge the locking plug outwardly from said recess. A mounting plate 74 is secured to the missile about the recess 64 by a plurality of screws 76, and has an opening 78 therein of the same shape as the cross-sectional configuration of the inner end of an erected fin. The opening 78 is smaller than the mouth of recess 64, and hence the plate forms a rim 80 against which a peripheral retaining flange 82 on the plug 66 can abut.

The plate 74 is of substantial thickness and has a locking groove 84 extending around the periphery of the opening 78, said groove being of a size to receive the retainers 54 and 56. The plate 74 also has a pair of spaced guides 88 thereon, one guide being received in each of the notches 58 and 60. Each guide has a cam slot 90 therein to receive pivot pin portions 55 and 57 of the retainers 54, 56, which portions 55 and 57 confront the notches 58 and 60. Ther guides 88 may be made with an inner portion integral with the plate 74 and an outer portion made separately and secured, as by welding, to the plate, the retainers 54, 56 first being placed in position.

The plug 66 is so shaped that the portion just above the retaining flange 82 thereof fits snugly within the interior of the erected fin adjacent the retainers 54 and 56. The upper portion of the plug has a cam-like surface 92 thereon, and spaced notches 94 are provided to permit the plug to extend into the fin past the guides 88.

The operation of the fin 40 is best shown in FIGS. 7 and 8. The surfaces 42 and 44 are first collapsed against one another. The collapsed fin is then wrapped around the missile, as is shown in full lines in FIG. 7. The locking plug 66 is held in a depressed position, against the force of the springs 68, by the retainers 54 and 56, the pivot pin portions 55 and 57 of the retainers being positioned in the outermost portions of the cam slot 90. When the fin is released from its wrapped position it will tend to erect itself, the fin being indicated at an intermediate position by the broken lines in FIG. 7. As the fin becomes erect the retainers 54 and 56 spread apart and are guided by the cam slot 90 into the peripheral locking groove 84. The locking plug 66 is made free to move as the flanges spread, and moves into the interior of the fin until the final position shown in FIG. 8 is reached. When the fin 40 is fully erect, and the locking plug 66 is in place, said fin is quite rigid and can withstand considerable aerodynamic loading.

While only one locking device is shown to be employed in the fin construction of FIG. 3, a plurality thereof may be provided if desired. Similarly, the number of guides employed in the fin construction of FIGS. 7 to 10 is optional. In both fin constructions there must be enough locking devices or guides to insure strength sufficient to withstand aerodynamic loads encountered in flight.

The specific dimensions of a wrap-around fin for any particular application may be determined by calculation, such factors as panel load requirements, fin material and heat-treat properties, and missile body diameter being taken into consideration.

Obviously, many modifications and variations of the present invention are possible in the 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.

What is claimed is:

1. In an aerial missile, a missile body, a fin comprising a pair of resilient, flexible sheets each having a generally arcuate cross-section, a leading edge, a trailing edge, a tip edge and a root end, said sheets being arranged with their concave sides facing each other and with said leading edges, said trailing edges and said tip edges contacting and bonded together, said root ends and the central portions of said sheets being free and normally bowed apart when said fin is in an erect position, thereby providing a rigid hollow airfoil of symmetrical cross-section, said fin becoming flat and flexible upon movement of said bowed sheets and root ends toward each other and into engagement, said sheets having at least one pair of aligned notches, one notch of said pair extending inwardly from and being positioned centrally of the root end of each sheet, a pivot pin attached to each sheet at said root end and confronting said notch, means mounted on said missile body and connected with said root ends for securing said fin to said body and for permitting said fin to be wrapped about said body when said fin has been made flexible by movement of the central portions and the root ends of said sheets into engagement, said securing means including a forward hinge plate, an aft hinge plate, a forward hinge pin, and an aft hinge pin, said hinge plates each having a bore therein and being secured to said missile body in aligned, spaced apart relationship, said hinge pins being secured to said fin at the opposite extremities of said root ends, said forward hinge pin projecting beyond said leading edges and being slidably and rotatably received within said bore in said forward hinge plate, and said aft hinge pin projecting beyond said trailing edges and being slidably and rotatably received within said bore in said aft hinge plate, and means attached to said body and engageable with said pivot pins for securing said fin is an erect position, said last mentioned means including a locking device, said device being attached to said missile body and having therein an elongated slot including an enlarged central por-

tion, both said pivot pins being received within said slot and being positioned within said enlarged central portion when said sheets and said root ends are in engagement, and being positioned at opposite ends of said slot when said fin is in an erect position with said sheets and said root ends bowed apart.

2. In an aerial missile, a missile body, a fin comprising a pair of resilient, flexible sheets each having a generally arcuate cross-section, a leading edge, a trailing edge, a tip edge and a root end, said sheets being arranged with their concave sides facing each other and with said leading edges, said trailing edges and said tip edges contacting and bonded together, said root ends and the central portions of said sheets being free and normally bowed apart when said fin is in an erect position, thereby providing a rigid hollow airfoil of symmetrical cross-section, said fin becoming flat and flexible upon movement of said bowed sheets and root ends toward each other and into engagement, said sheets having at least one pair of aligned notches, one notch of said pair extending inwardly from and being positioned centrally of the root end of each sheet, a pivot pin attached to each sheet at said root end and confronting said notch, means mounted on said missile body and connected with said root ends for securing said fin to said body and for permitting said fin to be wrapped about said body when said fin has been made flexible by movement of the central portions and

the root ends of said sheets into engagement, said securing means including a guide, said guide being secured to said missile body in a position confronting said notches and having a cam slot therein, both of said pivot pins being disposed within said slot, and means attached to said body and engageable with said pivot pins for securing said fin in an erect position, said last mentioned means including a retainer secured to the outside of each said sheet at said root end, said missile body having a recess means therein positioned to confront said root ends, said recess means including a peripheral groove portion of a size to receive said retainers and said pivot pins when said fin is in an erect position with said sheets and said root ends bowed apart, a locking plug receivable within said recess means and adapted to extend into the interior of said erect fin, and resilient means positioned to urge said plug into said fin.

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