

Feb. 2, 1960

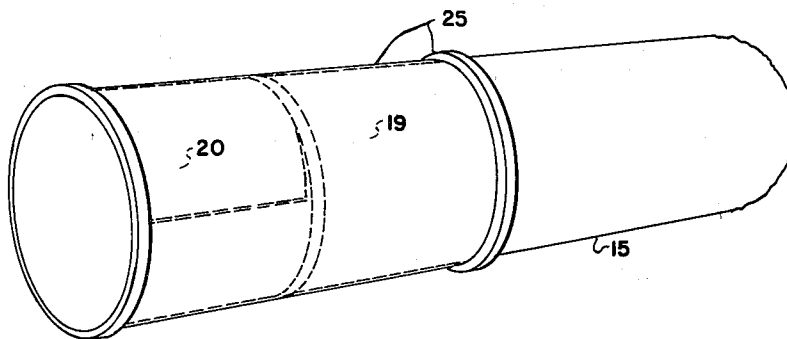
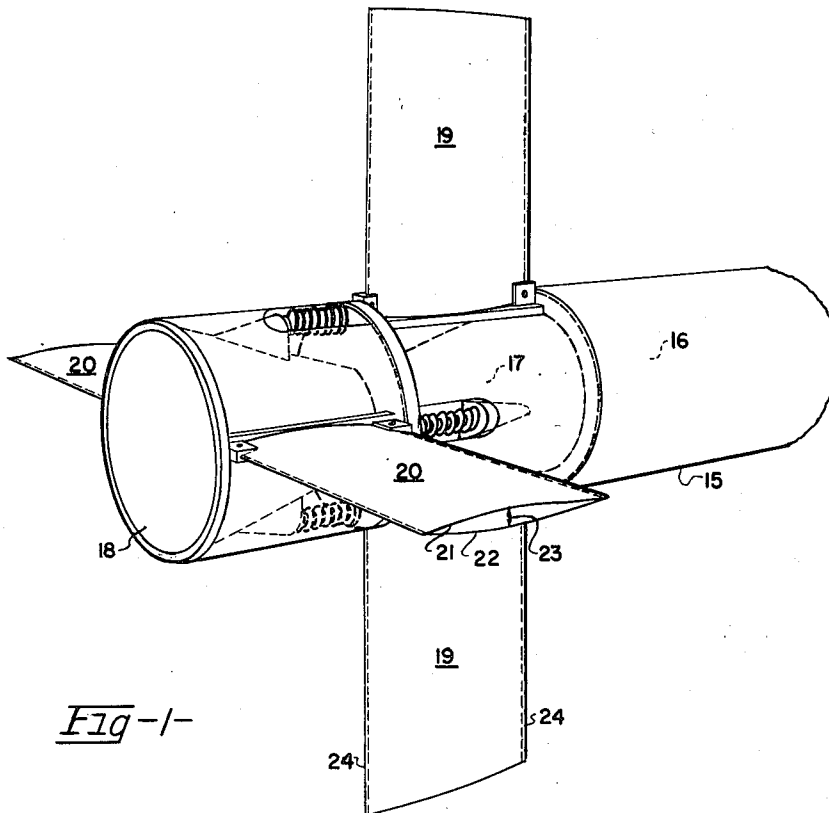
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2,923,241

FOLDING STABILIZING FINS

Filed Sept. 9, 1957

5 Sheets-Sheet 1



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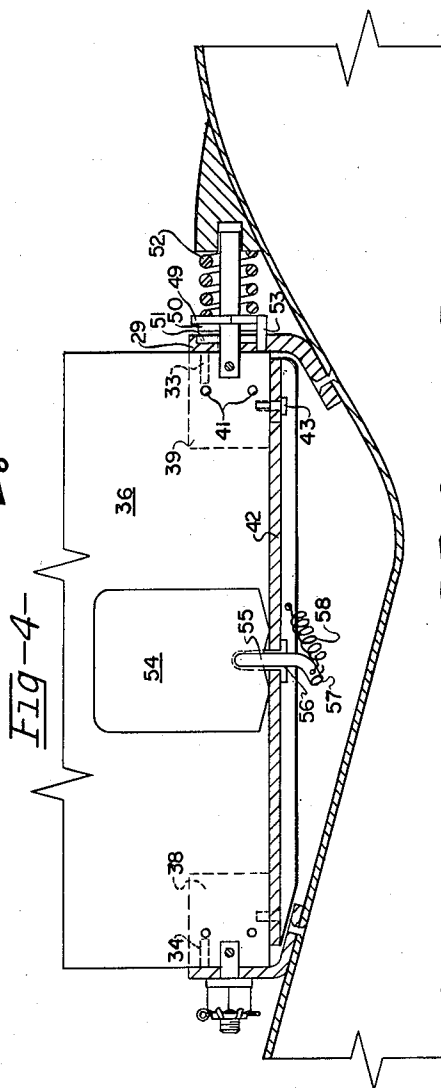
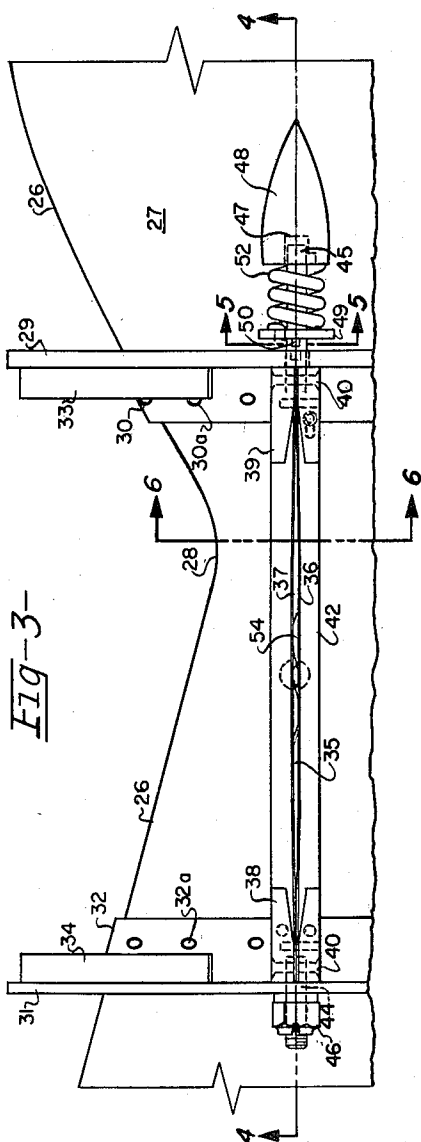
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5 Sheets-Sheet 2



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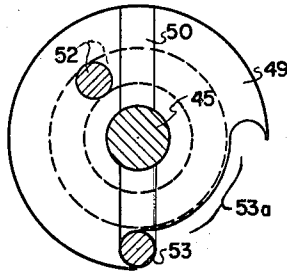


Fig-5-

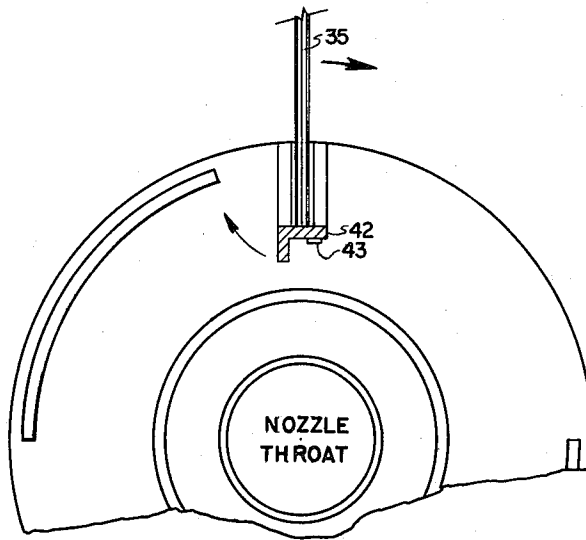


Fig-6-

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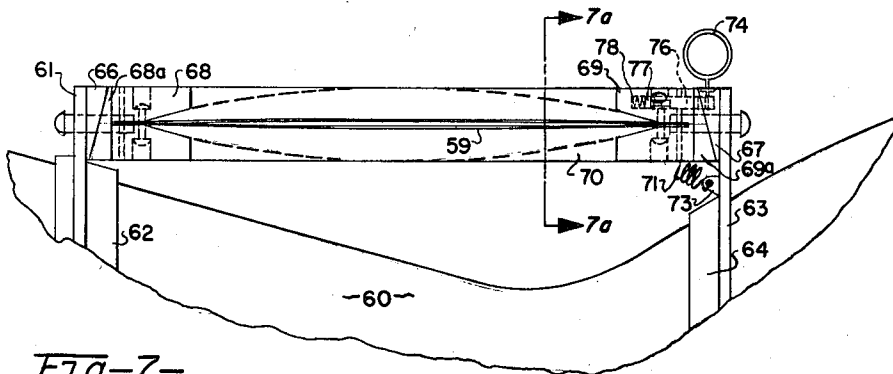


Fig-7-

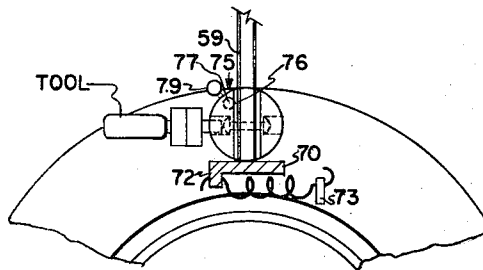


Fig-7a-

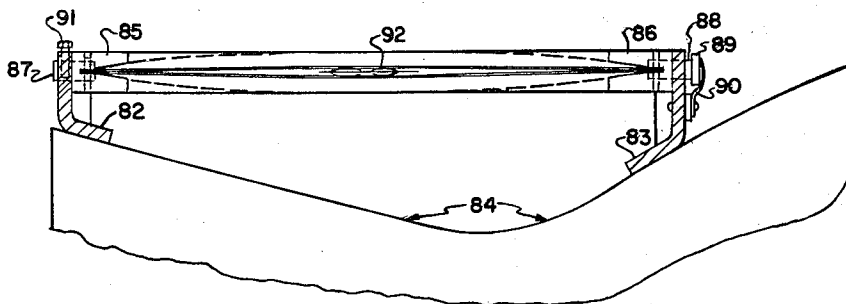


Fig-8-

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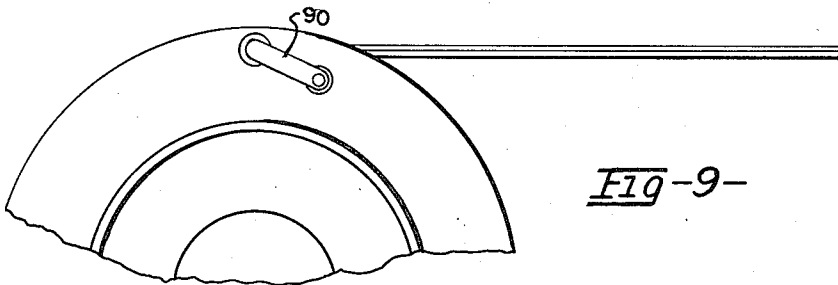


Fig-9-

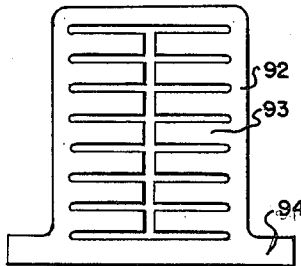
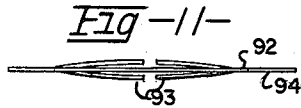


Fig-10-

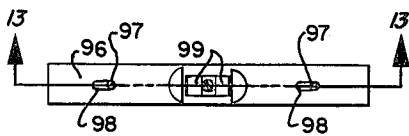


Fig-12-

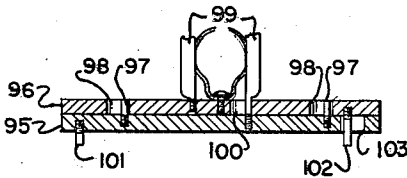


Fig-13-

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2,923,241

FOLDING STABILIZING FINNS

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Application September 9, 1957, Serial No. 682,655

13 Claims. (Cl. 102—50)

The present invention relates to the provision of stabilizing fins for projectiles, such as rockets, missiles and the like, and is concerned with the provision of stabilizing fins of the kind which may be collapsed or folded while the projectile is stored but which are released when the projectile is loaded to automatically assume operative position when fired.

Many arrangements of stabilizing fins of the kind described have been proposed but have not come into use because of various drawbacks such as relative complexity, excessive weight or lack of positive operation, which drawbacks are overcome by the novel construction of this invention.

The novel stabilizing fin assembly will be hereinafter described and illustrated as applied to rocket propelled projectiles but it is understood that the invention is not restricted to any particular means of propulsion of the projectile.

It is important that the weight of a rocket body and accessories should be kept as low as possible so that the useful load of fuel and explosive or other material carried should be as great as possible.

Accordingly, it is an object of the invention to make use of a type of material for the fin which is lighter than any previously utilized while amply strong, when properly formed and supported, for the purpose.

Since stabilizing fins should be accurately positioned and sufficiently strongly supported to resist stresses imposed thereon, another object is to provide means for insuring retention of the fins in an operative position.

Another object of the invention is to provide an installation for the folding fins of this invention which may be easily and accurately installed either during production of a missile or rocket, or fitted to such projectiles already produced.

Another object of the invention is to provide a fin contour producing minimum resistance at very high speeds.

With these and other objects in view, the invention comprises a stabilizing fin construction for projectiles in which the fins are formed of two thin sheets of metal bowed oppositely along their longitudinal axis and so mounted that the sheets may be pressed together in superposed relation and wrapped around the projectile, the mounting of the fins being such that when released from wrapped condition, the fins automatically assume an operative position.

In the drawings:

Fig. 1 is a fragmentary perspective view of the tail end of a large missile fitted with the fin assembly of my invention, the fins being shown in open or operative position;

Fig. 2 is a perspective view of the parts shown in Fig. 1 with the fins in folded or stowed position;

Fig. 3 is a fragmentary plan view of the rear end of a smaller type of rocket than is shown in Figs. 1 and 2, the fins being shown in flattened position prior to wrapping them around the rocket;

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Fig. 4 is a section on the line 4—4 of Fig. 3;

Fig. 5 is a detail view on an enlarged scale, looking in the direction of the arrows 5 in Fig. 3;

Fig. 6 is a section on the line 6—6 of Fig. 3, the view having been rotated through 90°;

Fig. 7 is a fragmentary view in said elevation showing a modified form of fin actuating means, the fins being shown in flattened position prior to wrapping;

Fig. 7a is a fragmentary view on a larger scale looking in the direction of the arrows 7a in Fig. 7 and showing a tool applied to cause flattening of a fin preparatory to wrapping it around the projectile;

Fig. 8 is a longitudinal section showing a tangential mounting arrangement for the fins;

Fig. 9 is a fragmentary front elevation of the fin arrangement shown in Fig. 8;

Fig. 10 is a front elevation on a larger scale of a resilient opening element arranged between the plates of the fins shown in Fig. 8;

Fig. 11 is a plan view of the elements shown in Fig. 10;

Fig. 12 is a plan view of a tool that may be used in manipulating the fin mountings; and

Fig. 13 is a section on the line 13—13 of Fig. 12.

Referring now to Fig. 1, the numeral 15 indicates generally a large rocket or missile. Such rocket propelled projectiles comprise a combustion chamber 16 followed by a Venturi throat 17 and exhaust nozzle 18. Vertical fins 19 and horizontal fins 20 are shown mounted over the throat and nozzle section of the missile. Missiles such as that shown must travel considerably faster than the fighter planes from which they may be fired, which now travel at supersonic speeds. At such high speeds, all support and control surfaces must provide minimum frontal areas and therefore should be as thin as possible, while still providing a streamline contour. The invention achieves the desired result by forming fins from a pair of sheets 21 and 22 of very thin material, such as spring steel less than .01 inch thick. Such material is known generically as shim stock and is utilized for such purposes as producing steel measuring tapes of the type which can be wound into a small container. The sheets utilized in this invention are preferably cut to the required form and bowed about the axis extending outwardly of the missile, as clearly shown at 23 in Fig. 1, in production and previous to heat treatment. The sheets are then connected as by bonding along their front and rearward edges 24 but are left free of attachment of one another at their transverse top and bottom edges. A suitable material for bonding together longitudinal edges is "Epon 6" or "Epon 8" which are epoxy resins, or "Pliobond" which is a rubber base material, and numerous other adhesives also made by the Minnesota Mining & Manufacturing Company. The fins are arranged so they may be flattened and wrapped around the projectile while in storage to economize space and protect the fins from damage as shown in Fig. 2 and may be retained in wrapped condition by a removable cap 25. Arrangements for mounting the fins will be explained in Figs. 3 through 8. Cap 25 may be withdrawn when the missile is readied for operation or pushed off by the insertion of the rocket into a firing tube, the resilience of the fins and the arrangement of the fin mounting means insuring that the fins are immediately extended into operative position, on removal of the cap or when the projectile is fired from the firing tube.

In Fig. 1, the fins 19 and 20 as before stated, are shown mounted on a large missile means for erecting, the fins being merely indicated, but such means will be fully explained with reference to later figures.

Referring now to Figs. 3 through 6, the folding fin construction of the invention is shown applied to a typical rocket having a single nozzle 26, body 27, and throat

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portion between body and nozzle, as indicated at 28. A radially extending flange 29 which may be of split construction may be welded or secured on the body of the rocket by a laterally extending flange 30 attached by rivets 30a to the rocket and a similar radial flange 31 and laterally extending flange 32 secured to the end of the nozzle by rivets 32a. The radial flanges are provided with horizontally extending interrupted flanges 33 and 34 projecting toward one another, the purpose of which will be later explained. Each fin, as generally indicated at 35, is identical in construction and mounting, and therefore, only one will be described in detail.

The fin comprises a pair of fin sheets of tough resilient material 36 and 37 bonded together along their forward and rearward edges but free of each other at top and bottom transverse edges.

The sheets of the fin are held at the lower corners by holding blocks 38, 39 having the shape clearly shown in Figs. 3 and 4. The blocks 38, 39 clamp the bonded edges of the fins between them and define the contour of the edge portions of the fin when the latter is in operative position. The blocks may be produced in any suitable manner, as for instance, by small aluminum castings of each half which are secured together by rivets 40 nested in holes drilled part way through the base or thicker portion of each half of the block, and locating pins 41 secured in one half of the blocks and fitting into holes in the other half block. The blocks at each edge of the fin are connected by a bar 42 of angular section secured to one block but free to slide to the required amount on the base of the opposite block by slots in the bar sliding over pins 43 in Fig. 4, screwed into the base of one block, the bar being held against the base of the block and guiding for sliding movement against it by the flat heads of the pins. The blocks 38, 39 will therefore be rotated in unison but may be moved closer or further apart.

The blocks 38, 39 are pivotally mounted on flanges 29, 31 by mounting means comprising short lengths of coaxially positioned shafts 44, 45 held in the blocks by the rivets 40, the edges of the fins being cut out to clear the shafts. Shaft 44 rotates in a hole drilled in flange 31 and is provided with a threaded end on which a castellated nut 46 is mounted and held in adjusted position by a cotter pin to prevent axial movement of shaft 44 while permitting rotation thereof on flange 31. Shaft 45 is extended through a hole drilled in flange 29 and the end thereof is journaled in a hole 47 drilled in an abutment 48 welded on body 27 of the missile shaft and having limited axial movement in said hole. A disc 49 is mounted immovably on, or is formed integral with, shaft 45 and abuts the outer face of flange 29 to limit movement of shaft 45 toward the flange. Disc 49 is provided with a diametrically extending feather 50 (Fig. 5) adapted to fit into a groove 51 formed on the forward face of flange 29.

A stiff helical compression spring 52 is mounted surrounding shaft 45 and under compression between the disc 49 and the face of the abutment 48. One end of the spring is bent axially and anchored in a hole in the disc 49 while the other end is extended axially and anchored in a hole in abutment 48. A pin 53 mounted in flange 29 engages in a peripheral cut-out 53a in the edge of disc 49, the length of the cut-out enabling shaft 45 with disc 49 to be rotated about 90° in one direction, when the feather 50 has been pushed out of the groove 51. Such rotation and axial movement of the shaft will both compress and twist up spring 52, the disc and shaft being rotated by the spring 52 when freed of constraint until stopped by pin 53 at which time feather 50 will be positioned opposite groove 51 and will be engaged therein by the pressure of the spring, while the natural resilience of the sheets, after being held under constraint in flat position, may be relied on to spring the sheets apart from one another when relieved from

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constraint. This action may be assured by mounting a thin stiff spreader plate 54 between the sheets. The spreader plate may be turned by a tang 55 projecting through a hole and drilled boss 56 on the underside of bar 42, the edges of the thin sheets being notched to clear the tang when folded flat. A short lateral extending arm 57 projects from the tang and one end of helical spring 58 is secured to said arm, the other end of the spring being hooked into a hole provided in the flange of bar 42.

In the modified fin actuating arrangement shown in Figs. 7 and 7a, fins 59, similar to fins 35, in Figs. 3 and 4, are mounted on the nozzle section of a rocket, as indicated at 60. A rear mounting ring flange 61 with radial projecting flange 62 and forward mounting ring 63 with lateral projecting flange 64 being arranged similarly to the embodiment of the invention previously described with respect to Figs. 3 and 4. On diametrically opposite locations on the facing surfaces of flanges 61, 63 disc shaped cam faces 66, 67 are welded.

Fins 59 are secured by their lower opposite corners by mounting blocks 68, 69 which are provided with lateral cam faces on discs 68a, 69a secured to the mounting blocks in any suitable manner to cooperate with cam faces 66, 67.

A bar 70 of angular section is arranged between the mounting blocks similarly to the bar 42 described in reference to Figs. 3 and 4. The means effective to move blocks 68, 69 together comprises a helical tension spring 71 having one end hooked in a hole in the flange 72 of bar 70 and small bracket 73 projecting from annular flange 63. Preferably, a groove is formed between the abutting surfaces of the mounting block cam face and the cam face on the annular flange on which it is mounted, for instance, by a groove cut, as by drilling, when the mounting block is in position for wrapping the fin, at which time the cam faces on the blocks will be in contact with the cam faces on the mounting rings over their whole surfaces inwardly in the face of each engaged cam surface. A pin 74 inserted in the aligned grooves will hold the mounting blocks in position against the pull of spring 71 until a covering cap (not shown) is put in place.

To hold the mounting blocks in operating position a latch generally indicated at 75 in Fig. 7a is provided and comprises a slidable bolt 76 arranged in a hole 77 drilled in an edge of a mounting block 69, the bolt being adapted to engage in an aligned hole in cam face 67. A coil spring 78 is mounted in hole 77 between the end thereof and the end of the bolt, a knob 79 connected to the bolt by a flat connecting piece extending through a slot from the hole to the surface of the block being provided to withdraw the bolt.

Referring now to Figs. 8 and 9, a modification of the invention is illustrated having the fins arranged to extend tangentially to the longitudinal axis of the projectile. A pair of split peripheral mounting flanges 82, 83 secured, as previously described, on the nozzle portion of projectile 84 and a pair of mounting blocks similar to those previously described is provided, but the blocks are mounted on rectangular short shafts 87, 88 arranged for sliding movement in rectangular openings broached through the peripheral flanges 82, 83. Shaft 88 projects slightly beyond the outer surfaces of the flange 83 and is provided with a plate 89, limiting inward movement of the shaft under the force exerted by a flat spring 90. The edgewise rigidity of the sheets of the fins when held in wrapped condition is relied on to overcome the inward force. The other shaft 87 may be held against movement by a screw 91 extending through the flange 82 and shaft. The fins produced, as previously described, and mounted in the mounting blocks, as previously explained, when released from a wrapped condition are bowed apart by their natural resiliency and retained in operative position by the non-rotating mounting blocks.

While the natural resilience of the sheets forming the fin may be relied on to secure opposite bowing of the sheets when released from wrapped condition, it may be preferred to provide auxiliary means to insure such opposite bowing. Such means may take the form of the device shown in Figs. 10 and 11 which comprises a thin flat sheet 92 of resilient material with a series of transverse fingers 93 shaped to a bowed contour before heat treating the sheet to give it a spring temper. A frame portion 94 which is the full width of the sheets forming the fin is bonded between the edges of the sheets to retain the device in place. The plate 92 and fingers 93 may be flattened with the fin and wrapped with them yet would materially increase the force tending to snap the fin to straight position when released from constraint in wrapped condition and to bow it outwardly.

Referring to Figs. 12 and 13, a convenient tool is shown for effecting the flattening of the bowed sheets by spreading apart the mounting blocks in which the fins are secured.

The tool comprises two flat bars 95, 96, the bar 96 being in the form of a channel in which bar 95 is slidably nested. The bars are connected together for limited axial movement by studs 97 extending through slots 98 in bar 96 and secured in the other bar 95.

A pair of half handles 99 are provided, one being secured to bar 96 while the other extends through a slot 100 to engage in bar 95. Pin 101 projects downwardly from bar 95 and pin 102 projects downwardly from bar 96 through slot 103.

By the use of the tool described with the pins 101 and 102 engaged in the rivet holes in the mounting blocks, the latter are readily moved apart to enable the fins to be flattened and wrapped around the projectile and a cap slipped over the base of the projectile to hold the fins in wrapped condition as long as is required.

While the fins specifically described have been shown as generally rectangular in outline, it is to be understood that other shapes may be utilized, as for instance triangular in form, any slight movement other than that in the case of rectangular fins being within the flexure limits of some adhesive materials such as rubber base commercial adhesives at the bonded edges of the thin metal sheets.

It is believed that the foregoing description of the arrangement of various embodiments of the invention makes unnecessary any detailed description of the operation of the various embodiments so that a brief summary only is now given.

The form of the invention of Figs. 1 and 2 is shown to indicate the adaptabilities of the invention to large missiles, etc. and that shown in Figs. 9 and 10 to small projectiles while the remaining figures illustrate various ways in which the invention may be carried into effect.

Various preferred embodiments have been specifically described and shown by way of illustrative examples only and not by way of limitation since modifications of the described embodiments of the invention may be made by those conversant with the art without departing from the scope of the invention, as defined by the appended claims.

I claim:

1. A folding stabilizing fin assembly for projectiles such as missiles, rockets and the like comprising: a pair of sheets of thin, tough, resilient material bonded together along their forward and rearward edges and bowed away from each other between said edges; fin holding means engaging the opposite edges of the fin at the base thereof and shaped to define a predetermined contour of the forward and rearward edge portions of the fin; and mounting means secured on the projectile for said holding means and arranged to enable the spacing of the holding means from each other to be changed, the fin holding means when moved apart enabling the sheets forming the fin to be flattened to enable them to be

wrapped around the projectile, and moved toward one another when the thin sheets of the fin assume their operative outwardly bowed contour.

2. A folding stabilizing fin assembly as set forth in claim 1 and in addition comprising: resilient means urging said fin holding means in a direction to reduce the spacing between them to thereby outwardly bow the skins of the fin apart; and means limiting said movement of the fin holding means.

3. A folding stabilizing fin assembly as set forth in claim 2 and in addition comprising supplementary means positioned between the sheets of the fin to aid them to assume their bowed apart position when released from wrapped position.

4. A folding stabilizing fin assembly for projectiles such as missiles, rockets and the like, comprising: a pair of sheets of thin, tough, resilient material bonded together along their forward and rearward edges and bowed away from each other intermediate said edges; fin holding means engaging the opposite edges of the fin at the base thereof; mounting means secured on the projectile for said holding means and arranged to enable the spacing of the holding means from each other to be changed, the fin holding means when moved apart enabling the sheets forming the fin to be flattened to enable them to be wrapped around the projectile, and moved toward one another when the thin sheets of the fin assume their operative outwardly bowed contour; resilient means urging said fin holding means in a direction to reduce the spacing between them; and means to hold said fin holding means in operative position.

5. A folding stabilizing fin assembly as set forth in claim 4 and in which said resilient means is arranged as a combined compression and torsion helical spring.

6. A folding stabilizing fin assembly as set forth in claim 5 and in addition comprising: a supplementary member arranged between the sheets of the fin and aiding the fin, when released from wrapped condition, to assume a radial position relative to the projectile and to bow the sheets outwardly from one another.

7. A folding stabilizing fin assembly as set forth in claim 4 and in which said mounting means comprises: stationary parts secured on said projectile; a shaft extending from each of said fin holding means into engagement with said stationary mounting means, at least one of said shafts extending through a hole in said stationary mounting means, said resilient member being arranged to surround said shaft; an abutment on said projectile in which one end of said resilient member is mounted; a stop and retaining member mounted on said shaft, the other end of said resilient member being engaged in said member; a part on said stationary mounting means engaged by said stop and retaining member when the fin holding means reach operative position when released from wrapped condition, said stop and retaining member being released when said fin is flattened preparatory to being wrapped about the projectile.

8. A folding stabilizing fin assembly as set forth in claim 4 and in addition comprising: an elongated member extending between said fin holding means and constraining them to simultaneous rotational movement while permitting said fin holding means to move relatively to one another axially of said elongated member.

9. A folding stabilizing fin assembly for projectiles, such as missiles, rockets and the like, comprising: a pair of sheets of thin, tough, resilient material bonded together along their forward and rearward edges and bowed away from each other between said edges; fin holding means engaging the opposite edges of the fin at the base thereof; mounting means secured on the projectile for said holding means and arranged to enable the spacing of the holding means from each other to be changed, the fin holding means when moved apart enabling the sheets forming the fin to be flattened to enable them to be wrapped around the projectile, and moved

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toward one another when the thin sheets of the fin assume their operative outwardly bowed contour; a tension spring tending to rotate said fin holding means in a direction to return said fin holding means from wrapped condition to operative condition; cam means mounted on at least one of said fin holding means and on said mounting means to effect the movement of said holding means toward one another to enable the sheets to assume bowed apart position; and means to lock said stabilizing fin in operative position.

10. A folding stabilizing fin assembly as set forth in claim 9 wherein said means to lock said stabilizing fin in operative position comprises: latch means mounted on at least one of said fin holding means and on a co-operating portion of the fin mounting means, said latch means being engaged to retain the mounting means in operative position when the mounting means reaches that position but being released before the sheets are flattened.

11. A folding stabilizing fin assembly as set forth in claim 9 and in addition comprising: an elongated member extending between said fin holding means and constraining them to simultaneous rotational movement while permitting said fin holding means to move axially of said elongated member.

12. A folding stabilizing fin assembly for missiles, rockets and the like, comprising: a pair of sheets of thin, tough resilient material bonded together along their forward and rearward edges and bowed away from each

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other between said edges, the resilience of said sheets enabling them to be flattened upon each other and wrapped around the projectile and when released from the flattened condition to assume their bowed apart configuration; fin holding means engaging opposite longitudinal edges of the fin at the base thereof; and fin mounting means having stationary parts secured to the projectile, at least one of said holding means being connected to said stationary mounting means so as to have limited movement toward and from the other of said fin holding means.

13. A folding stabilizing fin assembly for missiles, rockets and the like, as set forth in claim 12 and in addition comprising a shaft projecting into said stationary fin mounting means but held against rotation therein to which shaft said movable fin holding means is secured; resilient means urging said movable fin holding means toward the other fin holding means; and means limiting the movement of said movable fin holding means.

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