Aug. 18, 1959 R. M. LOCKWOOD 2,899,773

AERIAL TOY

Filed Feb. 25, 1957

FIG. 2

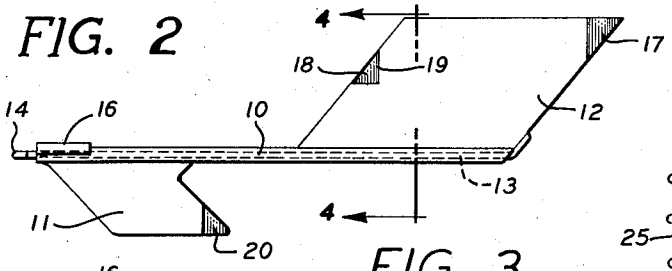
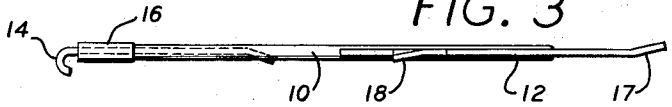


FIG. 3



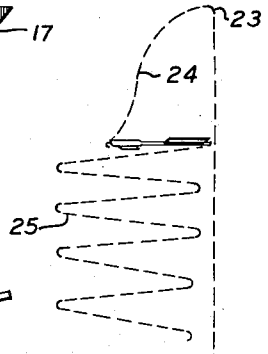


FIG. 6

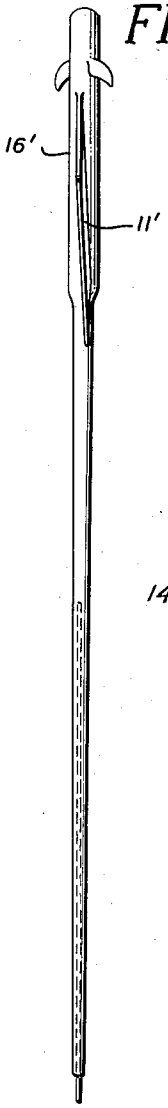
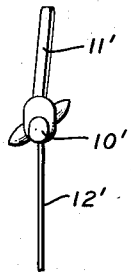


FIG. 7



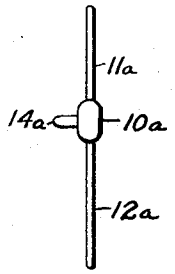


FIG. 8

FIG. 5

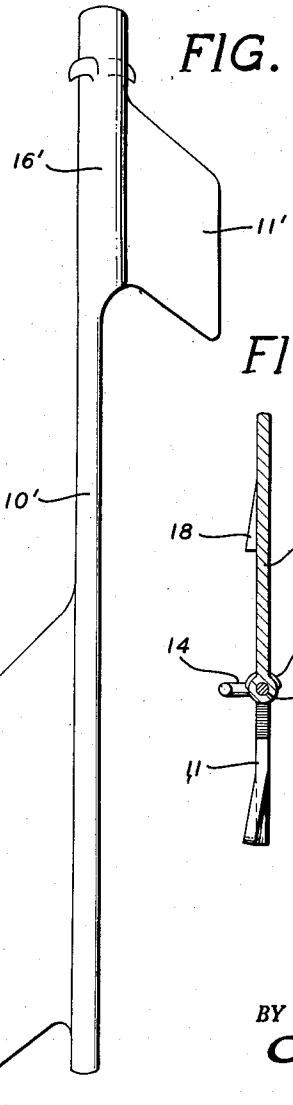
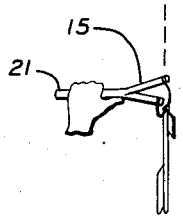


FIG. 4

FIG. 1



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AERIAL TOY

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Application February 25, 1957, Serial No. 641,988

14 Claims. (Cl. 46—74)

This application is a continuation in part of my pending application Serial Number 433,594, filed June 1, 1954, and since abandoned.

This invention relates to an aerial toy, adapted to be catapulted upwardly at high velocity with a flight similar to that of a dart into the atmosphere to a considerable height and which will descend with an auto-rotating motion at a relatively slow speed.

More specifically, the invention aims to provide an aerial toy having a structural form adapting it to be catapulted in substantially straight-line ascent at relatively high velocity and which, upon starting its descent, will change attitude to an auto-rotating condition for slow descent.

To attain the dart-like ascent, the toy is constructed in a manner to rotate about its longitudinal axis so long as it retains the momentum of initial upward propulsion, whereby to attain maximum climbing characteristic, and adapted to assume the auto-rotating position in response to the pull of gravity, for the descending movement.

A further object is to provide such an areial toy which will be relatively simple and inexpensive in construction.

Other objects will become apparent in the ensuing specifications and appended drawing in which:

Fig. 1 is a schematic diagram illustrating the operation of the toy;

Fig. 2 is a side elevational view of one form of the invention;

Fig. 3 is an inverted plan view of the toy as shown in Fig. 2;

Fig. 4 is a transverse sectional view of the toy as shown in Fig. 2;

Fig. 5 is a side view of an aerial toy embodying a modified form of the invention;

Fig. 6 is a plan view of the said modified form;

Fig. 7 is an end view of the said modified form; and

Fig. 8 is an end view of a preferred form of the invention.

Referring now to the drawing in detail, I have shown, in Figs. 2, 3, and 4, a toy embodying a spar **10** having a leading airfoil wing **11** secured to its forward end and a trailing airfoil wing **12** secured to its rear end. Wings **11** and **12** are disposed in a common axial plane of the spar **10**. The toy may be molded of a synthetic resin plastic material, reinforced by a length of wire **13**, molded into the spar **10** at its longitudinal axis, extending therethrough from end to end, and formed with a hook **14** projecting from its forward end for engagement with a launching catapult **15** (Fig. 1). Reinforcing wire **13**, of higher specific gravity than the molded plastic material, loads the leading end of the toy with a higher weight per unit area than the trailing end. The leading end is additionally weighted by a weight **16** just rearwardly of launching hook **14**.

Wings **11** and **12** are securely attached (as by being molded integrally) to the sides of spar **10** or along lines parallel to its axis, on diametrically opposite sides thereof. The wings have an acute angular parallelogram

planform, with their respective leading and trailing edges inclined rearwardly and away from the spar **10**. The leading wing **11** is of relatively small area and the trailing wing **12** is of relatively large area (as shown in Fig. 2 it is approximately four times the area of wing **11**, being roughly twice as long and twice as wide). Wing **12** has at its trailing tip a trim tab **17** which is inclined laterally from the plane of the body portion of the wing **12** at a low angle, less than 30 degrees shown in Fig. 3. It is provided with a trim tab **18** in its leading edge, inclined laterally to the opposite side thereof from trim tab **17**, and roughly parallel to the latter. Tab **18**, in side view, is embodied within the plan area of the wing **12** and is formed as an integral portion thereof along its leading edge, offset laterally along a bend line **19** which is normal to the axis of spar **10**.

Wing **11** likewise has at its trailing tip a trim tab indicated at **20**, which is inclined laterally and rearwardly to the opposite side (with reference to the tab **17**) of the common plane of the wings **11** and **12**. Thus, the tabs **17** and **20** and the tab **18** cooperatively provide screw-impeller surfaces with reference to the longitudinal axis of spar **10**, for inducing rotation of the toy around that axis during the high-momentum ascent of the toy.

In the operation of the toy, it may be launched, as shown in Fig. 1, by means of a conventional rubber band catapult or "sling shot" illustrated at **15** in Fig. 1. With the frame **21** of the catapult held substantially horizontally as shown, the launching hook **14** is inserted into the depending loop of the rubber band, and the rear end of the toy is grasped between the thumb and forefinger, of the other hand. The toy is then retracted downwardly, stretching the rubber band, and is released between the arms of the fork of the catapult frame. The high momentum thus imparted to the toy, concentrated in its forward end because of the higher specific gravity thereof, maintains the longitudinal axis of spar **10** lined up with the flight path, and the trim tabs **17**, **18**, **20** reacting to the flow of air along the wings **11** and **12**, cause the toy to rotate slowly about its longitudinal axis, assisting in stabilizing the alignment of said axis with the flight path.

As the toy reaches the zenith of its ascent course, the dissipation of momentum will allow it to stall on its trailing end at the point indicated at **23**, whereupon it will tip laterally owing to the higher specific gravity of its leading end, will drop one or two feet (as indicated at **24**) by gravity during such lateral tipping movement, and will then go into a spin as indicated at **25** in Fig. 1.

Referring now to the invention as disclosed in Figs. 5, 6 and 7, instead of the reinforcing wire for adding weight, the front end of spar **10'** is weighted by a head **16'** of enlarged diameter, to which the leading wing **11'** is integrally joined. The trailing wing **12'** of several times the area of leading wing **11'** (e.g. approximately four times the area) is formed integrally with the narrow portion of spar **10'** at its rear end, and projects from the side of the spar diametrically opposite wing **11'**. The two wings **11'** and **12'** may lie roughly in a common plane, although, as shown, the leading wing **11'** is preferably given a very slight inclination or twist with reference to the plane of the rear wing **12'**, so that aerodynamically the two wings and the spar joining them may be regarded as constituting a screw of extremely high pitch.

An important characteristic of the toy is the proportioning of the leading wing, which I have discovered has the function of a sensitive control device in determining whether the toy will or will not go into a spin upon dropping back from its zenith of flight. For example, if the leading wing is wider than a critical width by only a small dimension (between $\frac{1}{32}$ inch and $\frac{1}{16}$ inch variance)

the toy will in most cases fail to go into a spin but instead will plummet back to earth like an arrow. The critical maximum variance mentioned above is for a toy (e.g. that shown in Figs. 4–6) having a length of approximately 8½ inches, a leading wing having its outer edge approximately one inch from the longitudinal axis of the spar **10**, having an average length of approximately 1⅜ inches, and having its forward edge spaced approximately ½ inch rearwardly from the forward tip of the spar where it joins the same; and in which the trailing wing has its outer edge at a distance of between 1 1/16 inches and 1⅛ inches from the spar axis and an average length of approximately 3 inches, with its rear edge approximately ⅜ inch from the rear end of the spar where it joins the same. The foregoing dimensions are not to be considered as essential dimensions of the toy (since it will be apparent that the toy could be constructed on a larger or smaller scale) but may be taken as defining generally the proportions of the toy, the ratios between these several dimensions being important.

The angle of longitudinal pitch of the forward wing with reference to the spar axis may be so slight (e.g. less than 5 degrees) that the two wings may be regarded as lying approximately in a common plane, and yet the toy will execute the flight pattern described above. The important object obtained by the invention is to provide a toy that can be relied upon to have an arrow-like ascent to a considerable height (50 feet elevation is consistently obtained by the toy in the specific embodiment and specific dimensions set forth above) and at the same time can be relied upon to assume the autorotative position promptly upon dropping back from its stalling position. This has proven to be difficult of attainment and, as stated, the approximate proportioning stated above is critical in attaining dependable results.

As shown in Figs. 5, 6 and 7, the launching hooks may be disposed at an acute angle to the plane of the wings. However, a preferred construction is one in which a launching hook **14***a* extends at right angles to the plane of the wing as shown in Fig. 8.

It will be understood that the configuration or shape of the wings is relatively unimportant, whereas the area ratio, i.e. the ratio between the respective areas of trailing and leading wings, is a controlling factor in the proper performance of the toy. In a toy having generally the proportions shown, this ratio should fall in a range between 2:1 and 2.5:1. The correct ratio, however, varies somewhat with changes in mass balance (c.g. location), and it is the proper combination of the various factors discussed above that is vital to satisfactory performance.

In attaining the quick transition form arrow-like ascent to autorotative descent, an important factor is the size of the leading wing. As this area is reduced, the maximum height of ascent becomes less and less (because of premature transition from ascent into the auto-rotating condition) until such maximum height approaches that of the single wing (maple seed) configuration, which will ascend only a short distance before it flips into a spin. It is the right location and area ratio of the wings, in combination with the proper mass balance as described above, that achieves the desired results.

While the slightly helical inclination of the leading wing, as shown in Figs. 5, 6 and 7, does assist in attaining rotation of the toy about its longitudinal axis in the ascent, I find that this is not an indispensable feature of a toy having the mass balance and plan form configuration shown in Fig. 5. On the contrary, I find that a toy conforming substantially to the proportioning shown in Fig. 5 (as to outline configuration and distribution of mass shown in that figure as related to Fig. 8) will attain the same height, with a slow rotation during ascent, as the toy shown in Figs. 5, 6 and 7. Accordingly, attention is now directed to Fig. 8, which discloses a preferred form of my invention, fabricated as an injection molding from synthetic resin plastic material, the side view configuration of the toy being approximately as shown in Fig. 5, except that the single hook **14***a* projects normal to the common plane of the wings **11***a* and **12***a* rather than at an acute angle, and the leading wing **11***a* has a somewhat larger area in proportion to the trailing wing area. The wings **11***a* and **12***a* differ further from the wings **11'** and **12'** of Figs. 5, 6 and 7, in that they are both disposed in a common plane intersecting the axis of the spar **10***a*.

The ratio between areas of trailing and leading wings of Fig. 8 is preferably in the range between 2:1 and 2.5:1.

The reason why the toy in this form, with no helical inclination or trim tab on either wing, will operate as satisfactorily as the others, has not yet become apparent to me. An essential feature appears to be the fact that one wing lies ahead of and the other behind the center of gravity and the two wings are on diametrically opposite sides of the spar. This has proved to be an unexpected phenomenon, since I hade previously assumed that it was necessary to utilize trim tabs or a helical inclination of one of the wings to attain "spin stability" during ascent.

The form shown in Fig. 8 is the preferred form because it is the simplest and easiest to fabricate, not because it performs any better than the other forms of the invention, although it performs as well, as stated.

The leading wing, in addition to providing for maximum ascent (maximum delay of transition from linear travel along its longitudinal axis to auto-rotation), has the added function of providing stability once the auto-rotation has commenced. Should the toy be caught in a gust during auto-rotation and be flipped over, the effect of the leading wing is to enforce the renewal of auto-rotation without delay. The leading wing also functions to prevent a stall in which the device may plummet downward like an arrow, which often happens to the single wing configuration, especially when caught in a gust.

As the result of the proportioning described above, the toy achieves a dynamic balance such as to attain a transition from the arrow-movement ascent to the auto-rotating descent automatically as the result of the aerodynamic forces acting on the toy during its momentum-powered ascent.

I claim:

1. An aerial toy adapted to be catapult-launched to a substantial altitude with a rapid arrow-movement ascent, and to descend slowly with an auto-rotating action, comprising: a longitudinal spar having a leading end provided with a launching hook, and having its opposite end constituting a trailing end; a wing of relatively small area at said leading end; a wing of relatively large area at said trailing end; said wings being both disposed substantially in a diametral plane of the spar axis, on diametrically opposite sides thereof, and having respective side margins joined to opposite sides of the spar; a trim tab on the trailing corner of the forward wing; a trim tab in the leading edge of the rear wing, said trim tabs projecting diagonally with respect to said common plane in fore and aft directions to cause the toy to spin about its longitudinal axis during launching flight for facilitating attainment of height in said arrow movement; and means providing a weight mass on said spar at said leading end; the respective areas of said vanes being proportioned to provide a dynamic balance such as to achieve said transition from said arrow-movement ascent to said auto-rotating descent automatically as the result of aerodynamic forces acting on the toy during its momentum-powered ascent, on the one hand, and the result of aerodynamic forces acting on the toy near the summit of its flight, when the momentum of ascent has been substantially dissipated.

2. A toy as defined in claim 1, wherein said trim tabs are located close to the center of gravity of the toy so as to reduce drag during autorotation.

3. An aerial toy adapted to be catapult-launched to a substantial altitude with a rapid arrow-movement ascent, and to descend slowly with an auto-rotating action, comprising: a longitudinal spar having a leading end provided with a launching hook, and having its opposite end constituting a trailing end; a wing of relatively small area at said leading end; a wing of relatively large area at said trailing end; said wings being both disposed substantially in a diametral plane of the spar axis, on diametrically opposite sides thereof, and having respective side margins joined to opposite sides of the spar; said forward wing having an integral trailing corner portion extending rearwardly diagonally with respect to said plane of the spar axis to cause the toy to spin about its longitudinal axis during launching flight for facilitating attainment of height in said arrow movement; and means providing a weight mass on said spar at said leading end; the respective areas of said wings being proportioned to provide a dynamic balance such as to achieve said transition from said arrow-movement ascent to said auto-rotating descent automatically as the result of aerodynamic forces acting on the toy during its momentum-powered ascent, on the one hand, and the result of aerodynamic forces acting on the toy near the summit of its flight, when the momentum of ascent has been substantially dissipated.

4. A toy as defined in claim 3, wherein said trailing corner portion is located near the center of gravity of the toy, so as to reduce drag during autorotation.

5. An aerial toy adapted to be catapult-launched to a substantial altitude with a rapid arrow-movement ascent, and to descend slowly with an auto-rotating action, comprising: a longitudinal spar having a leading end provided with a launching hook, and having its opposite end constituting a trailing end; a wing of relatively small area at said leading end; a wing of relatively large area at said trailing end; said wings being both disposed substantially in a diametral plane of the spar axis, on diametrically opposite sides thereof, and having respective side margins joined to opposite sides of the spar; at least one of said wings having at least a portion thereof disposed diagonally with respect to said plane of the spar axis in a fore-aft direction to cause the toy to spin about its longitudinal axis during launching flight for facilitating attainment of height in said arrow movement; and means providing a weight mass on said spar at said leading end; the respective areas of said wings being proportioned to provide a dynamic balance such as to achieve said transition from said arrow-movement ascent to said auto-rotating descent automatically as the result of aerodynamic forces acting on the toy during its momentum-powered ascent, on the one hand, and the result of aerodynamic forces acting on the toy near the summit of its flight, when the momentum of ascent has been substantially dissipated, said diagonally disposed vane portion being located near the center of gravity of the toy so as to reduce drag during autorotation.

6. An aerial toy adapted to be catapult-launched to a substantial altitude with a rapid arrow-movement ascent, and to descend slowly with an auto-rotating action, comprising: a longitudinal spar having a leading end provided with a launching hook, and having its opposite end constituting a trailing end; a wing of relatively small area at said leading end; a wing of relatively large area at said trailing end; said wings being both disposed substantially in a diametral plane of the spar axis, on diametrically opposite sides thereof, and having respective side margins joined to opposite sides of the spar; said wings being arranged to cause the toy to spin about its longitudinal axis during launching flight for facilitating attainment of height of said arrow movement; and means providing a weight mass on said spar at said leading end; the respective areas of said wings being proportioned so that the ratio of area of the trailing wing to that of the forward wing is in the range between approximately 2:1 and 2.5:1 to provide a dynamic balance such as to achieve said transition from said arrow-movement ascent to said auto-rotating descent automatically as the result of aerodynamic forces acting on the toy during its momentum-powered ascent, on the one hand, and the result of aerodynamic forces acting on the toy near the summit of its flight, when the momentum of ascent has been substantially dissipated.

7. An aerial toy adapted to be catapult-launched to a substantial altitude with a rapid arrow-movement ascent, and to descend slowly with an auto-rotating action, comprising: a longitudinal spar having a leading end provided with a launching hook, and having its opposite end constituting a trailing end; a wing of relatively small area at said leading end; a wing of relatively large area at said trailing end; said wings being both disposed substantially in a diametral plane of the spar axis, on diametrically opposite sides thereof, and having respective side margins joined to opposite sides of the spar; at least one of said wings having at least a portion thereof disposed diagonally with respect to said plane of the spar axis in a fore-aft direction to cause the toy to spin about its longitudinal axis during launching flight for facilitating attainment of height in said arrow movement; and means providing a weight mass on said spar at said leading end; the respective areas of said wings being proportioned to provide a dynamic balance such as to achieve said transition from said arrow-movement ascent to said auto-rotating descent automatically as the result of aerodynamic forces acting on the toy during its momentum-powered ascent, on the one hand, and the result of aerodynamic forces acting on the toy near the summit of its flight, when the momentum of ascent has been substantially dissipated.

8. An aerial toy adapted to be catapult-launched to a substantial altitude with a rapid arrow-movement ascent, and to descend slowly with an auto-rotating action, comprising: a longitudinal spar having a leading end provided with a launching hook, and having its opposite end constituting a trailing end; a wing of relatively small area at said leading end; a wing of relatively large area at said trailing end; said wings being both disposed substantially in a diametral plane of the spar axis, on diametrically opposite sides thereof, and having respective side margins joined to opposite sides of the spar; the leading wing having at least a portion thereof disposed diagonally with respect to said plane of the spar axis in a fore-aft direction to cause the toy to spin about its longitudinal axis during launching flight for facilitating attainment of height in said arrow movement; and means providing a weight mass on said spar at said leading end; the respective areas of said wings being proportioned to provide a dynamic balance such as to achieve said transition from said arrow-movement ascent to said auto-rotating descent automatically as the result of aerodynamic forces acting on the toy during its momentum-powered ascent, on the one hand, and the result of aerodynamic forces acting on the toy near the summit of its flight, when the momentum of ascent has been substantially dissipated.

9. A toy as defined in claim 8, wherein the entire forward wing is disposed at a dihedral angle of less than 5 degrees relative to said spar axis plane.

10. A toy as defined in claim 9, wherein said leading wing has an area approximately one-fourth the area of the trailing wing.

11. A toy as defined in claim 9, wherein the radial width and axial length of the forward wing are each approximately one-half the corresponding dimensions of the trailing wing.

12. A toy as defined in claim 11, wherein the trailing vane is coincident with said spar axis plane.

13. An aerial toy adapted to be catapult-launched to a substantial altitude with a rapid arrow-movement ascent, until it reaches a stall condition, and to quickly go into

auto-rotating action from said stall and to descend slowly under auto-rotation, comprising: a longitudinal spar having a leading end provided with a launching hook and having its opposite end constituting a trailing end; a wing of relatively small area on said leading end; a wing of relatively large area on said trailing end; said wings being both disposed substantially in a diametral plane of the spar axis on diametrically opposite sides thereof and having respective side margins integrally joined to opposite sides of the spar; said wings being proportioned so that the ratio of area of the trailing wing to area of the leading wing is in the range between approximately 2:1 and 2.5:1, and so as to have a mass distribution providing a dynamic balance such as to achieve said transition from arrow movement ascent to said auto rotating descent automatically as the result of aerodynamic forces acting on the toy during its momentum-powered

ascent, on the one hand, and the result of aerodynamic forces acting on the toy near the summit of its flight, when the momentum of ascent has been substantially dissipated.

14. A toy as defined in claim 13, wherein said wings are both disposed in a common plane of the axis of the spar.

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