Dec. 17, 1957 D. H. GLEASON 2,816,764

AERIAL MISSILE

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Fig. 1.

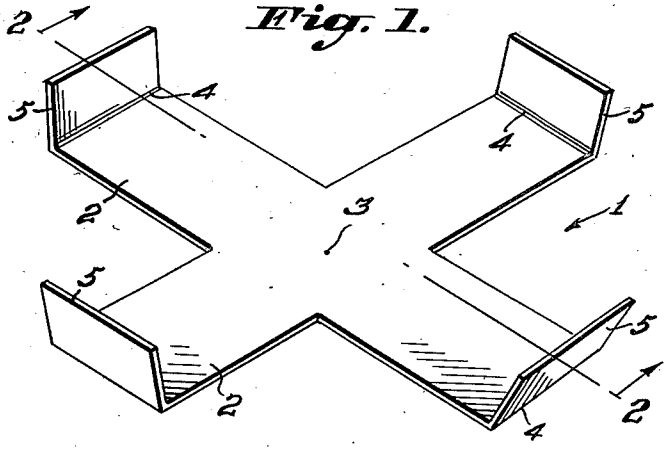


Fig. 2.



Fig. 3.

Fig. 7.

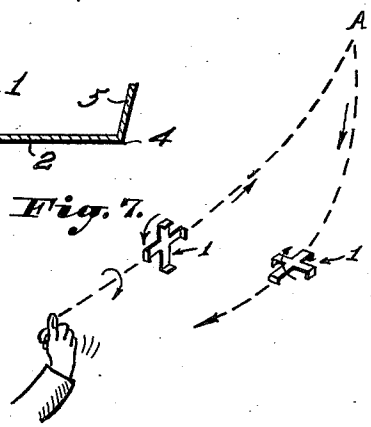


Fig. 6.

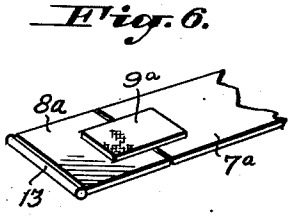


Fig. 4.

Fig. 5.

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AERIAL MISSILE

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10 Claims. (Cl. 273—106)

This invention relates to an aerial missile which, in various forms, and sizes, may be adapted to use as a toy, a gunnery target, or as an educational device for the demonstration of aerodynamic and other physical principles.

It is the principal object of my invention to provide an aerodynamic sailing device which, when properly launched with a combined motion of translation and rotation will sail outwardly away from the point of launching a certain distance, while inverting, and return substantially to the launching site.

A further object of the invention is to provide a device of the type aforesaid which, while simple and inexpensive, is very attractive and interesting to use as a toy or for other purposes, and with which an individual can acquire great proficiency in throwing with a reasonable amount of practice and experience.

A still further object is to provide an aerial projectile which can be made in a wide range of sizes and materials and, if desired, mechanically launched for travel in various paths and altitudes and subsequent return to the point of launching, for use as a target in gunnery practice similar to clay pigeon or skeet shooting.

Yet another object is the provision of a scientific device capable of use to demonstrate aerodynamic principles of flight involving combined rotation and translation.

Other objects and advantages will become apparent after a study of the following specification in connection with the drawing.

In the drawing:

Figure 1 is a perspective view of one form of the invention,

Figure 2 is a section taken in a plane identified by the line 2—2, Figure 1,

Figure 3 is a modified form using pivoting wing tips,

Figure 4 is a sectional view of one of the tips of the modification of Figure 3, as indicated by line 4—4, Figure 3, and showing the tip in the position it assumes on the outward trajectory, before inverting,

Figure 5 is a sectional view corresponding to Figure 4, but showing the manner in which the wing tips pivot downwardly after inversion of the projectile,

Figure 6 is a detail perspective view of one wing tip of a second modification showing how the flaps may be weighted to increase momentum and kinetic energy, and

Figure 7 is a view showing the manner in which the projectile may be launched and its general trajectory.

The conventional boomerang is a sickle-shaped device usually but not necessarily made of wood having a thickness of about one-sixth of the breadth and a breadth of about one-twelfth of the length which may be vary from 6" to several feet. The angle between the two arms may have a wide range of 70° to 120°. The peculiar flight characteristics of the missile by which it may be made to return to the vicinity of the thrower are due largely to the fact that the arms have skew or pitch of the order of 2° to 3° which in the case of a boomerang to be thrown with the right hand is clockwise looking from the ends

of the arms toward their junction. A boomerang of the type described is held vertically with concave edge forward, and thrown in a plane parallel with the ground, with as much spin as possible. Since the center of thrust of the component force induced by the pitch of the arms is offset from the center of rotation of the spinning missile, an unbalanced torque is applied by the relative wind as the missile rotates which causes it to precess; and since this torque is always at right angles to the axis of spin of the missile, the boomerang, after a period of outward travel continuously changes its course and, when properly thrown, will return to the vicinity of the thrower. As is also well known, the common boomerang in addition to the precession just described, rotates its axis of spin through approximately 90°. That is to say, the axis of spin lies substantially in a horizontal plane when thrown and rotates continuously as the missile traverses its path until, at the end of the flight the spin axis is substantially vertical and the arms horizontal.

I have invented a missile which can be thrown to follow a return trajectory but which unlike the conventional boomerang, is symmetrical about a central axis of spin, has no pitch or skew, and is capable of a trajectory lying substantially in a vertical plane, that is, it may be thrown to travel directly away from the thrower in a rising path and to return directly to or in the vicinity of the thrower, in a similar descending path substantially vertically coplanar with the outgoing path. Another distinction of my invention over a common boomerang is that, whereas the axis of rotation or spin of a boomerang rotates through approximately 90° during a complete flight, the axis of spin of the device forming my invention rotates through approximately 180°.

Thus, referring to Figure 1, reference numeral 1 identifies generally a one-piece missile of plastic, wood, or metal and having a plurality of equal coplanar arms 2 radiating in equiangularly-spaced relation from a common center 3 and through which the axis of spin passes normal to the plane of the arms. From Figure 2 it will be noted that except for the tips, the arms of the preferred form lie in a single or common plane. However, it is permissible and, in fact, may result in improved stability, to slightly curve the arms so that, for example, as viewed in Figure 1, the central portion at the juncture of the arms is raised slightly above the radially outward portions of the arms. Thus viewing the missile as in Figure 1, the arms extend smoothly from this raised portion slightly downwardly and outwardly and then upwardly, near their ends, to the respective bends 4 or, alternatively, merge with a smooth curve upwardly into vanes.

The ends of the wings or arms are bent in the same direction as indicated at 4 to form tips or stabilizing vanes 5. Preferably the bends are relatively sharp, instead of a gradual curve and may be of any value between 45° and 90°. In Figure 2 an angle of about 75° is shown measured from the plane of the missile in the direction of bending. The tips or vanes may have a length of about one-fifth to one-sixth of the length of the arms, which is defined as the radial distance from center 3 to the bend or fold 4.

Figures 3, 4 and 5 disclose a modified form in which the body may be of wood or plastic with sheet metal wing tips each hinged to a respective arm. Thus, referring particularly to Figure 3, a central or body portion consists of four integrally united arms of equal length. A flap 8 of the same width as the arms and a length ratio as previously explained, is hinged to the tip of each of the arms by any suitable flexible means shown merely by way of example, as a piece of adhesive tape 9. The central portion of the body may have a well or depression 10 which in the position of the parts shown in Figure 3, is struck downwardly from the plane of the paper. A

weight or mass **11** of any suitable material has one end each of four sections of cord **12** secured thereto. The other ends of the cords are centrally secured to the end edge of the respective flaps or tips **8**. Figure 4 shows the position of the parts at launching wherein the flaps are substantially coplanar with the arms **7** and prevented from pivoting downwardly by the adhesive tape. At this time, weight **11** is held by gravity within its offset or downwardly-struck pocket **10** and the wind resistance to translation is a minimum. As the device inverts, during the outward position of its trajectory, weight **11** drops out of pocket **10**, cords **12** are tensioned and pull the flaps **8** down to the approximate position shown upon Figure 5.

Figure 6 shows an end section of one arms *7a* of a modified form having flaps *8a* of wood with tape *9a*. The flap has a weight **13**, which may be a straight piece of wire secured along its radially outward edge to increase momentum of the moving missile and to effect downward pivoting of the flaps as soon as the missile has inverted. In both of the modifications or modified species, the weight **11**, cords **12** and pocket **10** may be dispensed with if desired where the flaps are sufficiently weighted or of sufficient mass to pivot downwardly by themselves following inversion.

In another modification, not shown, the tips of the arms are bent to curve gradually out of the plant of the arms instead of a sharp bend, as shown. As in the models disclosed, all arm tips are bent in the same direction and terminate at about the same angle to the plane of the arms as in Figures 1 and 2. The sizes, mass, moment of inertia and relative distribution of weight can be widely varied so long, of course, as the centroid of the composite structure is substantially at point **3**.

In use, the end of one arm of the missile is grasped between the right thumb and index finger with the tips extending upwardly, and by a flip of the wrist combined with arm motion, is given a spin and a translation upwardly and from the thrower. For best results the angle of launching will vary. When thrown into a gentle breeze of, say, five miles per hour, the preferred launching angle is about 30° to the horizontal, while on a windless day, the corresponding angle is about 45°.

As the missile moves along its trajectory each tip **5** during the forward half of each rotation reacts with the ambient air to impart a torque to the missile about an axis generally transverse to the trajectory and in the plane of the arms. Thus in accordance with well-known physical laws governing spinning bodies, the missile precesses about an axis generally coincident with the portion of the trajectory being instantaneously traversed and begins to invert. Thus, for example, referring to Figure 7 showing the trajectory greatly compressed, the missile is launched with the tips of the arms upwardly and is given a spin which has a counterclockwise direction looking down. The reaction torque due to relative wind of translation will tend to rotate the missile about an axis which is generally transverse to the trajectory in the plane of arms. The missile, due to its spin, then precesses about an axis generally coincident with the instantaneous portion of the trajectory. Since the axis of the applied torque is always about 90° ahead of the spin axis of the missile, precession continues until the missile is, at or a little before the point of farthest outward travel, fully inverted as indicated at Figure 7. The angle of climb increases as the missile reaches the outward portion of its trajectory, whereby it gains potential energy. The angle of tilt of the trajectory is usually from 30° to 60° at this point, depending upon the angle of launching and relative wind. From the highest point at the end of the outgoing trajectory the missile, still spinning, glides back in a generally parabolic path and lands at or near the point of launching with its wing tips pointed downwardly.

In the preferred method of launching, the first and second joints of the curved index finger lie underneath the end of one arm, and the tip of the thumb is used to compress the arm contiguous to the bend or joint between the arm and flap or vane. In fact, when launching a model with curved tips, the mid-portion of the thumb slightly overlies the curved portion. When launching a model with sharply bent tips, the thumb lies entirely on the flat arm closely adjacent or in side contact with the vane.

By adaptation of various known launching devices or catapults the invention may be projected with great kinetic energy and travel substantial distances from the point of launching and return thereto. This is of great advantage in gunnery practice because it enables subsequent inspection of the target for hits.

It will be clear from the foregoing that I have achieved the stated objects and purposes of the invention. The missile is easily fabricated from a wide range of suitable materials. With a reasonable amount of practice the missile can be made to perform in the manner described either for amusement, for use as a moving target in gunnery practice, or for the demonstration of aerodynamic and other physical laws as previously explained.

While I have shown the preferred form of the invention as now known to me, various modifications will occur to those skilled in the art after a study of the foregoing disclosure. Consequently I desire that the disclosure be taken in an illustrative rather than a limiting sense; and it is my desire and intention to reserve all such modifications as fall within the scope of the subjoined claims.

Having now fully disclosed the invention, what I claim and desire to secure by Letters Patent is:

1. In an aerial missile, a sheet of thin flat material defining a central portion and a plurality of equal arms radiating in equi-angularly spaced relation from said body portion, said portion and arms lying in a common plane, and stabilizing vane means attached to the ends of said arms, each said vane lying in a respective plane which in at least one horizontal position of the common plane of said arms, makes an obtuse angle with said common plane about a line normal to the longitudinal axis of its respective arm.

2. An aerial missile as recited in claim 1, said vane means being formed by turning the tips of each said arms in the same direction out of said common plane, all said arms terminating in a single plane parallel with and offset from the common plane of said arms.

3. In an aerial missile, a central body portion, a plurality of equiangularly spaced arms radiating radially from said central body portion, said portion and arms being flat and lying entirely in a common plane normal to the axis of symmetry of said missile, and a vane attached to the tip of each arm, each said vane in at least one position of said axis with respect to the horizontal plane, being turned in the same direction out of said common plane through an acute angle about a line perpendicular to the respective arms and parallel with said common plane.

4. An aerial missile as recited in claim 3, said body portion, arms and vanes comprising a unitary piece of flat sheet stock, all said vanes being substantially flat.

5. In an aerial missile, a generally planar body portion comprising at least two equiangularly disposed substantially coplanar arms radiating from a common center, the end of each said arms being bent about an axis normal to the longitudinal axis thereof to form a vane, all said vanes extending in the same direction out of the common plane of said arms.

6. In an aerial missile, a generally planar body portion comprising a plurality of equiangularly-disposed coplanar arms radiating from a common center, the distal end of each said arm being bent angularly about a line perpendicular to the radial dimension of the arm extending from said center, to form a vane at the distal end of each arm, all said lines being equidistant from said common center and all said vanes extending out of the common plane of said arms in the same general direction.

7. An aerial missile comprising four flat coplanar arms radiating in equiangularly-spaced relation from a common center, the width of each arm being less than its length, the distal end of each said arm being bent about a line normal to its longitudinal axis through an angle of from 45° to 90° measured in the direction of bending to form a vane, all said vanes extending in the same general direction out of the common plane of said arms and terminating in a second plane offset from and parallel with said common plane.

8. An aerial missile as recited in claim 7, each said vane being substantially planar and having a length, measured perpendicularly to said line, less than the corresponding length of its respective arm.

9. In an aerial missile, a thin flat sheet of material of uniform thickness shaped to define a central body portion and four equiangularly spaced arms radiating from a common center, each said arm being of uniform width and having a length of four to six times its width, the distal end of each arm being turned in the same general direction through an angle of between 45° and 90° measured in the direction of turning, about a line at right angles to the longitudinal axis thereof, to form a vane, all said vanes being turned through the same angle and the tips of all said vanes lying in a plane parallel with and offset from the plane of said arms.

10. In an aerial missile, four flat arms all lying in a common plane and radiating in equiangularly-spaced relation from a common center, all said arms being of the same dimension along respective radii extending from said center, the radially outward end of each said arm being bent through an acute angle about an axis perpendicular to said respective radii and in the same direction out of said common plane, to form a vane, all said arms and vanes being substantially identical and unconnected at their distal ends.

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