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Conner

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[54] **EXPENDABLE SELF-POWERED TARGET WITH STABILIZING CONTROL**

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[51] **Int. Cl.** **F41j 9/08**

[58] **Field of Search** 244/3.24, 79, 3.16, 3.21; 273/105.3, 105.4; 114/122, 144; 102/34.1

[56] **References Cited**

UNITED STATES PATENTS

1,280,803	10/1918	Miners	102/34.1
2,935,947	5/1960	Jagiello	244/3.21
2,953,442	9/1960	Hopper	273/105.3
2,957,417	10/1960	Musgrave	244/3.16
2,960,035	11/1960	Burton	244/3.21
3,198,031	8/1965	Templin	244/79
3,511,454	5/1970	Hamilton	244/79
3,563,501	2/1971	Jensen	244/79
3,735,985	5/1973	Layer	244/3.24

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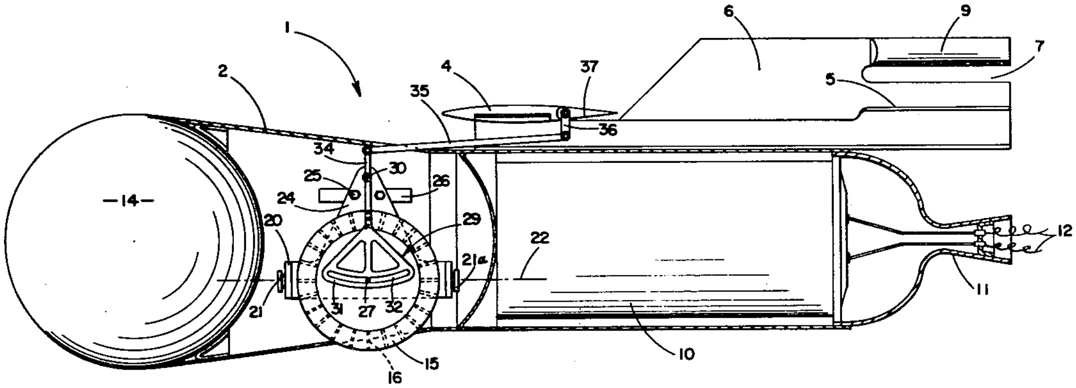
[57] **ABSTRACT**

A radar-augmented target pod to be launched from a drone aircraft and act as a flying target for weapon system crew training. The launching drone is recoverable for re-use, while the target pod is extremely simple and expendable after its one flight. It is powered by a JATO rocket unit for example, and has a simple air-driven direction-holding mechanism and an automatic weight shifting design to maintain substantially constant altitude until power burnout.

6 Claims, 4 Drawing Figures



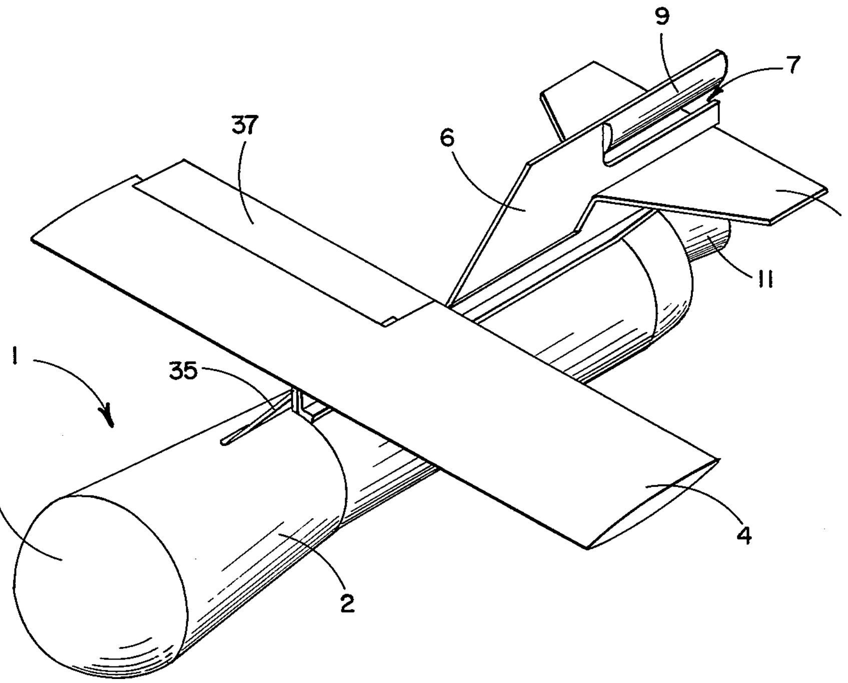


FIG. 1

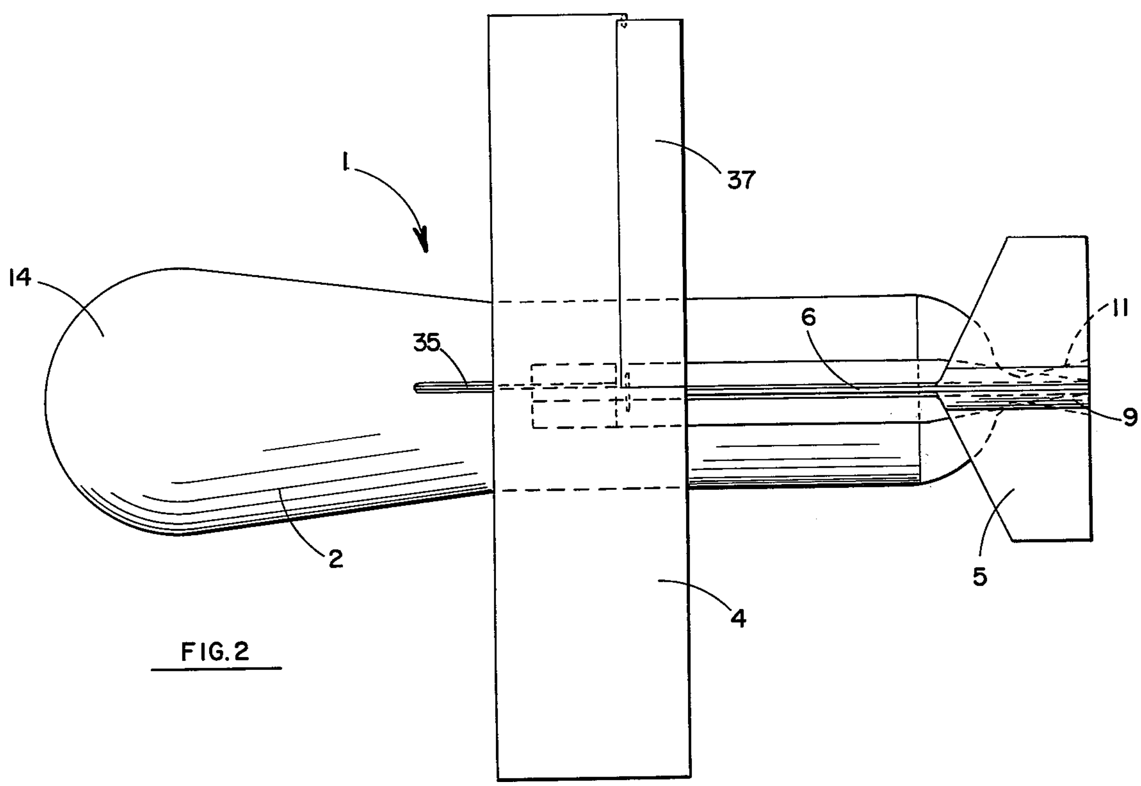


FIG. 2

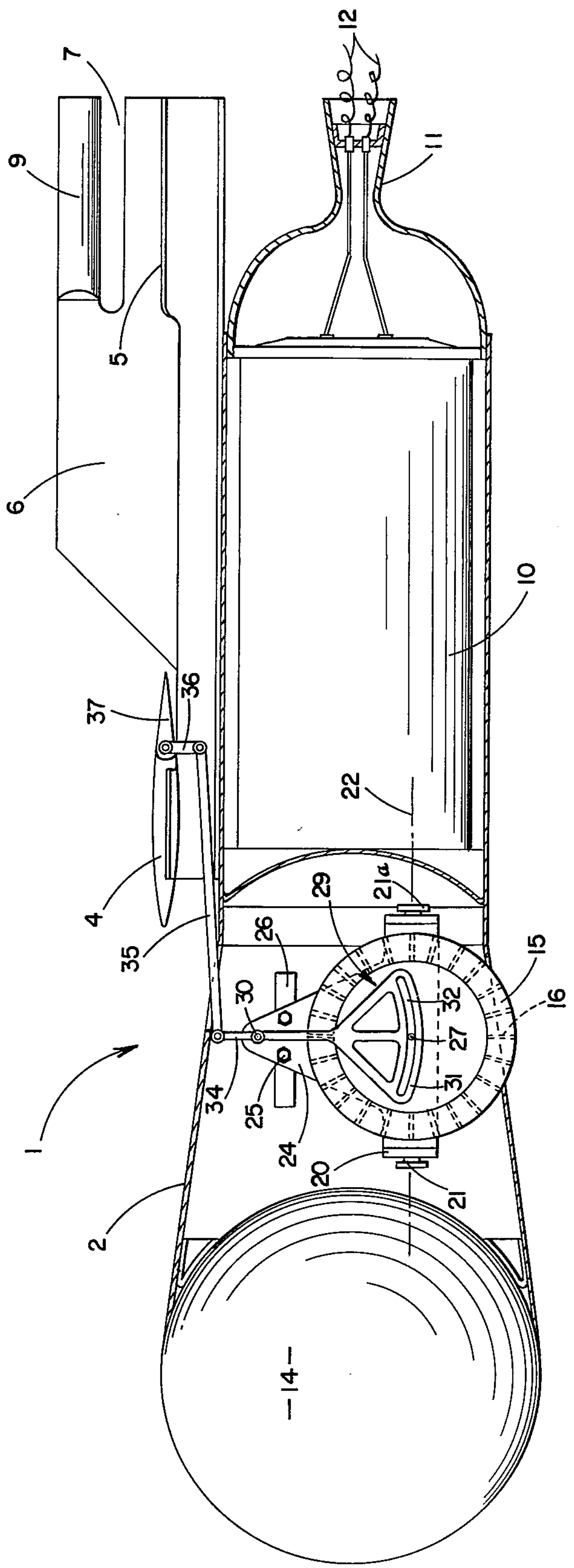


FIG. 3

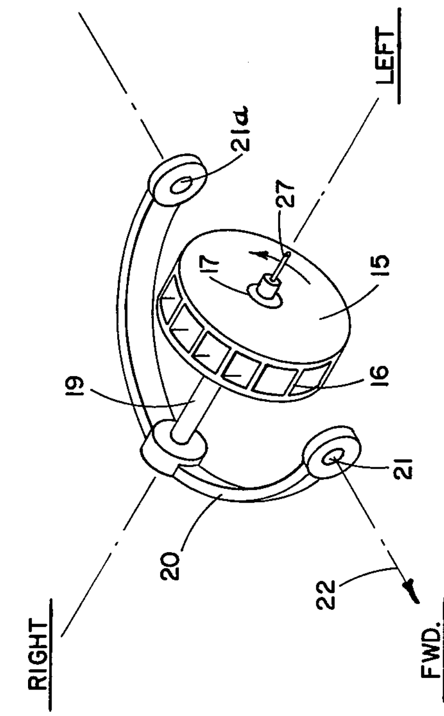


FIG. 4

EXPENDABLE SELF-POWERED TARGET WITH STABILIZING CONTROL

The present invention relates to aerial targets, and more particularly, to a cheap expendable target to be launched from a carrier aircraft, which target has automatic flight control and suitable characteristics for a weapon aimed at it for test purposes.

It is known to launch radio-controlled drone targets from the ground or from piloted aircraft for gun or missile testing and gun crew training, these drones being parachute-recovered and salvaged for reuse if not destroyed by weapon hits or crash landings. It is also known to tow a "flying" target from an aircraft at the end of a long tow line while missiles are fired at the target. Both these expedients are wasteful and unsuitable in several respects. Recovery, rebuilding and replacement of the drones is expensive, while automatic loss of the towed target and its long tow line is also expensive. Further, in the case of the towed target, an attack angle of the weapon from a head-on direction and up to a certain angle away from head-on is prevented due to the position occupied by the towing craft. These objections have made it desirable to find a better target system, but none has appeared yet.

It is an object of this invention to provide a new target for the function described which is workable and also economically disposable whether intercepted or not.

Other objects and advantages of the present invention will be noted in the detailed description of specific apparatus to follow.

Briefly, my target invention comprises a powered flying body to be launched from a small drone aircraft, the target having a radar reflector or other simple stores, for example, and having heading control and/or constant altitude to weapon intercept. The heading control is a unique air-powered or battery-powered gyro mechanism which uses the direct mechanical output of a spinning gyro to drive a linkage connected to a control surface. To achieve level flight of the target after launching from its carrier drone or aircraft, the longitudinal position of the center of gravity may be purposely varied to move forward accompanying acceleration of the target.

The invention will be more fully understood by reference to the following detailed description of a preferred embodiment illustrated in the accompanying drawings, wherein:

FIG. 1 is a perspective view of a powered pod target embodying the present invention.

FIG. 2 is a plan view of the target of FIG. 1.

FIG. 3 is a left elevation view, partly in section, of the target of FIG. 1, showing internal control apparatus.

FIG. 4 is an isometric diagram illustrating the arrangement of the control gyro in the fuselage.

Referring first to FIG. 1 for a detailed description of the present embodiment, a flying target 1 comprises a body or fuselage 2, wing 4, horizontal tail 5 and vertical tail 6. The vertical tail 6 carries a fore-and-aft hanger slot 7 open at the trailing edge of the tail 6. Above this slot 7, the vertical tail 6 has a substantially cylindrical longitudinal launch support 9. Under the wing of the target carrier aircraft (not shown) a pipe-like member is provided, into which the launch support 9 is loaded. The target 1 is thus carried supported by the tail until the launching moment when the target thrust carries it forward off of the carrier pipe. The carrier aircraft itself may be a remotely controlled drone, which can be turned aside after the target is launched.

As shown in FIG. 3, a JATO type rocket unit **10** is positioned within the fuselage **2**, with its nozzle **11** protruding aft. Conventional ignition wires **12** extend from the rocket unit **10** to the carrier aircraft for ignition and then break-away.

The nose of this target fuselage **2** carries a radar echo augmenting device **14** such as a Luneberg lens for example. Since the present target is to be small and inexpensive, the fuselage **2** may be only about **5** inches in diameter, for example, and the radar reflective device **14** is preferred to be the smallest diameter compatable with range of weapon intercept. The close-in launch requires the smaller lens. In the present illustration, the reflector **14** is slightly larger than the fuselage diameter.

Heading control of the target **1** is provided by a rate gyro-operated mechanism. As shown in FIGS. **3** and **4**, a gyro wheel or rotor **15** is mounted with its axis of rotation in a horizontal and lateral direction. The gyro rim carries buckets or impeller blades **16** which extend below the bottom of the fuselage **2** and are driven by the airstream.

Rotor **15** spins about a central rotor bearing **17** on the end of a rigid cantilevered mounting shaft **19** fixed rigidly at its right-hand end, for example, to half gimbal **20** lying normally in a horizontal plane and having two gimbal bearings **21** and **21**a at its pivot ends. These gimbal bearings **21** and **21**a are mounted along a fore-and-aft gimbal axis **22** on yoke arms of a bracket member **24** which is fixed solidly to the fuselage structure as by two bolts **25** attaching bracket **24** to a fixed fuselage member **26.** Thus in operation, rotor **15** is spinning in a vertical plane. A caging mechanism (not shown) may be provided, and counterweights (not shown) may be provided on half gimbal **20** to the left of the axis **22** to balance the gimbal and shaft assembly.

To the left end of rotor **15,** a small diameter, short flexible steel shaft **27** is fixed to the center of rotor **15** to rotate therewith. The purpose of this flexible shaft **27** will be described later.

The bracket **24** also has a bellcrank member **29** pivotally connected thereto at pin **30.** Bellcrank **29** has a lower suspended portion **31** in which a curved slot **32** is provided in a fore-and-aft direction, the slot radius being centered at the pivot pin **30.** The flexible shaft **27** protrudes through the center of this slot **32,** and the slot width is slightly greater than the diameter of flexible shaft **27,** so that when centered the shaft **27** will spin freely without contacting either the upper or lower side of the slot **32.**

A short bellcrank arm **34** extends upward from pivot pin **30** and has its end pivotally connected to the forward end of a push-pull rod **35** which extends to the exterior through a fuselage slot. The rear end of rod **35** is pivotally connected to an aileron horn **36** extending upward to be operatively connected to an aileron **37** hinged to the rear of the right-hand side of the wing **4.** The gyro rotor **15,** bellcrank linkage, and left end of the aileron **37** are all preferably located substantially at the fuselage center line plane for simplicity.

In operation, this heading control system automatically keeps the target **1** in a substantially straight flight path. Assume that during its flight, it starts to turn toward the left, for example, thus rotating about the vertical axis. With reference to FIG. **4,** this can be seen to cause gyro precession about the gimbal axis **22** in the direction to raise the end of the flexible shaft **27**. The bending resistance of shaft **27** is proportional to its deflection. This shaft **27**, thus acting as a rate spring, will contact the upper side of curved slot **32**, and due to rotor rotation in the direction indicated, the frictional physical reaction between the shaft **27** and slot **32** moves the bellcrank lower portion **31** forward. This moves the bellcrank arm **34** rearward and the bellcrank thus acts as an actuating member to rotate the aileron horn **36** rearward, hence rotating the aileron **37** upward at its trailing edge. This of course rolls the target **1** to the right and thus causes a right turn sufficient to cancel the original left turn and therefore bring the flexible shaft **27** back to the center of groove **32** and remove the aileron correction movement. The short bellcrank arm **34** being closer to the pivot pin **30** than is the slot **32**, causes a force multiplication between the frictional force on slot **32** and the force exerted in the push rod **35**.

It can be likewise seen that a right turn from straight flight will produce a left bank of the target **1** to again straighten its course.

The flexible shaft **27** is preferably provided with a rough surface such as a coating of diamond grit or the like, to increase its frictional force on the bellcrank slot **32**. The gyro rotation speed is restored by the airstream when the flexible shaft **27** is returned to center. It is important to note that the kinetic energy of the gyro rotor itself is used to cause the corrective control force, and not just the precession force alone, which is too small to use directly. No electrical power or actuation equipment is required to be carried by the target since the entire work is mechanically transferred from the airstream rotating the gyro. Rotor speed build-up is accomplished prior to launch while being carried under the carrier drone. Of course, the rotor **15** may be driven by a battery-operated motor (not shown), if desired, but for the expendable target purpose involved here, the rotor is required to operate for only about **70** seconds, for example. After release from the carrier drone, the interception of the target **1** by the missile fired at it occurs considerably prior to the burnout time (**70** seconds in this example) of the JATO unit **10**.

Level flight of the target **1**, within limits, is maintained by utilizing the target center of gravity shift due to propellant burning. In flight, the target **1** accelerates from launch to burnout. The increased velocity of this simple craft would normally causes simultaneous climb. A forward-burning propellant is used in the rocket unit **10**, thus reducing the weight on the rear side of the center of gravity and causing a nose-heavy condition which keeps increasing throughout the powered flight. The climb normally due to acceleration is calculated to be equal and opposite to the reduction in altitude normally due to the nose-heavy condition, thus providing a substantially level target flight until burnout.

To enable economy, the fuselage **2** is preferably a simple tube sized to fit closely around a standard JATO unit, say of **5** to **6** inch diameter for example. The horizontal and vertical tail **5** and **6** can be pressed steel. The gyro is placed in a forward position necessary to keep the major weight components well forward. Also, the gyro is preferably made of as large a rotor diameter as is possible, this being provided by the availability of most of the fuselage height.

While in order to comply with the statute, the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise the preferred form of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

What is claimed is:

1. An airborne target comprising a body, a thrust motor in said body, means for launching said target into flight and starting said motor, radar reflecting means in said body, a gyro rotor, means for spinning said rotor, a movable direction control member on said target for controlling the course heading of said target, and means responsive to gyro precession for deflecting said direction control member in a turn-nulling direction, said latter means including a rotor-driven element movable solely and directly by the rotational energy of said rotor, said rotor-driven element being brought into direct physical mechanical contact with a spinning portion of said rotor by precession due to heading change of said target.

2. Apparatus in accordance with claim **1** including a wing on said target body, and wherein said direction control member comprises a single aileron on said wing.

3. Apparatus in accordance with claim **1** wherein said rotor spinning means comprises blades on the periphery of said rotor, said rotor extending partially into the airstream where the airstream spins said rotor by impinging on the blades so exposed.

4. An airborne target comprising:

a. a body having a thrust motor and radar reflecting means in said body;

b. means for launching said target into flight and starting said motor;

c. means in said target for maintaining substantially constant altitude until stoppage of said motor;

d. direction maintaining control means in said target including a gyro rotor and means for spinning said rotor;

e. a movable direction control member on said target;

f. a rigid axle shaft concentric with the spin axis of said gyro rotor, said rotor being cantilever-mounted at one end of said rigid shaft;

g. a half gimbal having the other end of said rigid shaft connected to its mid-point, said rigid shaft extending normally laterally of said target, and the ends of said half gimbal located on a fore-and-aft gimbal axis in said target body;

h. a short flexible spring shaft attached to the center of said rotor and rotating therewith on the other side of said rotor from said rigid shaft, said flexible shaft having a roughened surface;

i. a rotor-driven element having a slot fitting over said flexible shaft and normally spaced therefrom, said slot positioned such that precession of said rotor caused by a directional change of said target brings said flexible shaft against one side of said slot in frictional driving relation; and

j. actuating means connected from said rotor-driven element to said direction control member.

5. Apparatus in accordance with claim **4** wherein said actuating means comprises force-multiplying means.

6. Apparatus in accordance with claim **4** wherein said rotor-driven element is pivotally mounted in said target about a pivot point, said slot being arcuate with the center of arc at said pivot point, and wherein said actuating means comprises a force-multiplying linkage means.

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