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[54] **RADAR-AUGMENTED SUB-TARGET**

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[52] **U.S. Cl.** ..... **343/18 B,** 273/102 R, 273/102.2 R

[51] **Int. Cl.** **H01q 15/14**

[58] **Field of Search** . 343/18 B; 273/102 R, 102.2 R

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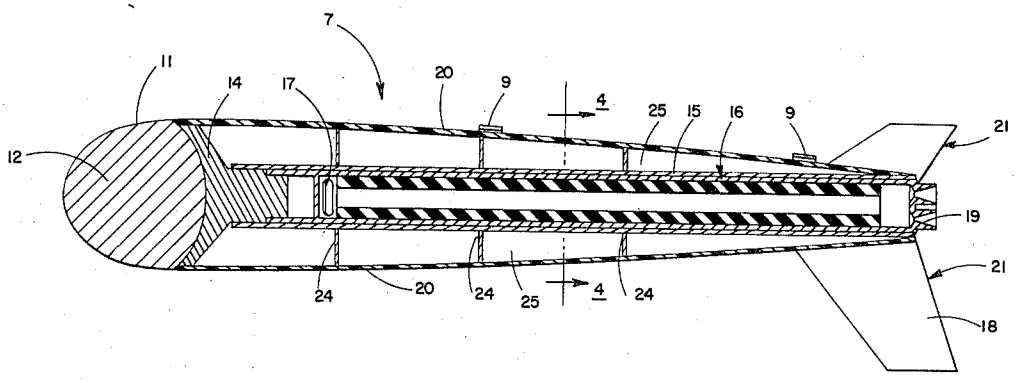
[57] **ABSTRACT**

A remote controlled drone aircraft carrying radar-augmented targets or so-called "sub-targets" which are rocket powered and can be individually launched from the drone when at the proper place and time to provide training for crews firing a missile at the target, and to provide a target for missile quality assurance and lot acceptance testing. The targets are extremely simple and economical, comprising only a symmetrical plastic body with fixed tail surfaces, and a cylindrical rocket motor inside. A removable nose cover initially masks the radar reflector of each target except one until ready for use.

12 Claims, 9 Drawing Figures



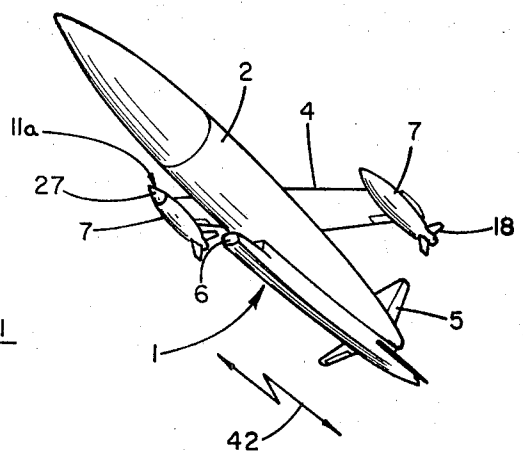


FIG. 1

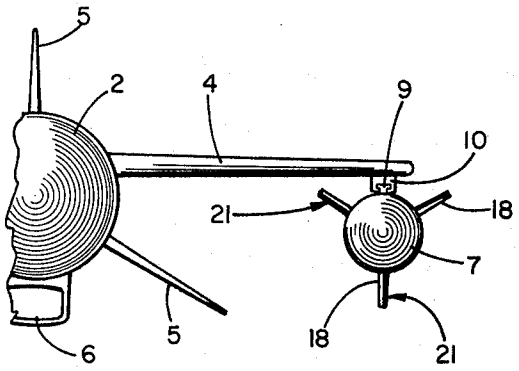


FIG. 2

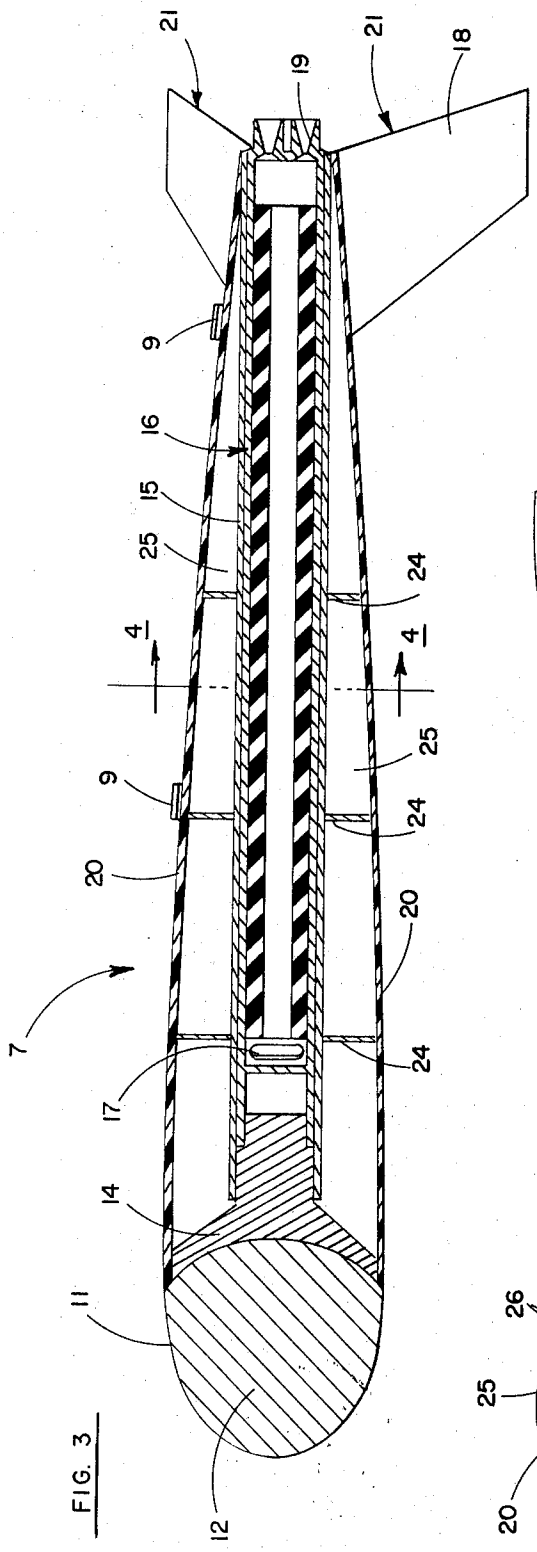


FIG. 3

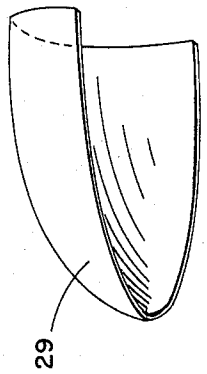


FIG. 7

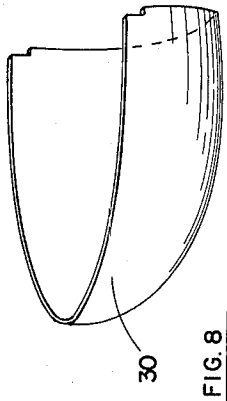


FIG. 8

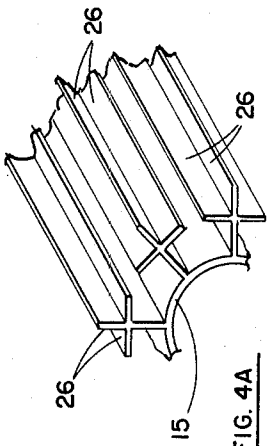


FIG. 4A

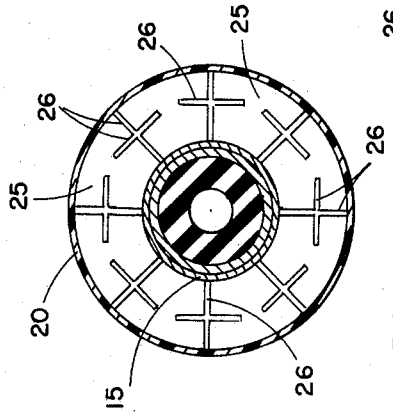


FIG. 4

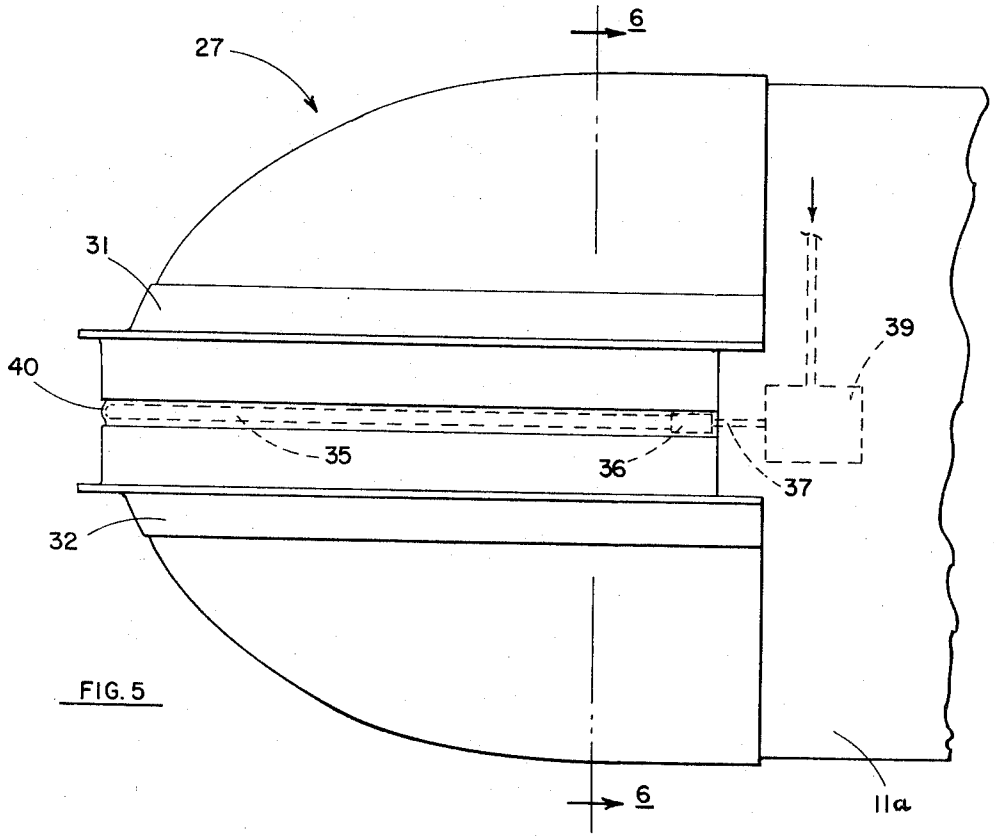


FIG. 5

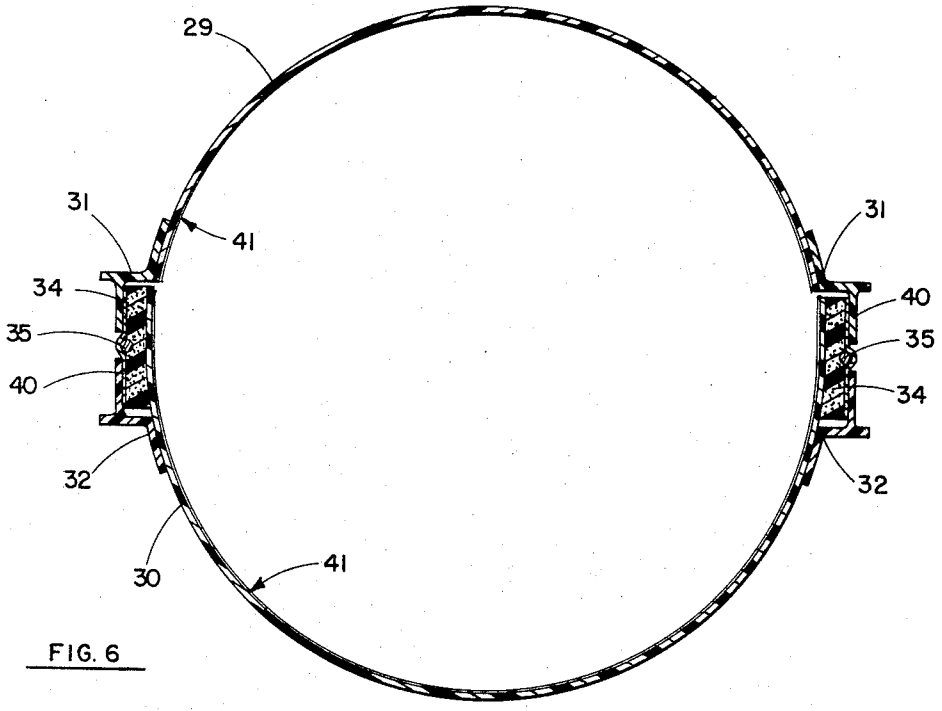


FIG. 6

RADAR-AUGMENTED SUB-TARGET

The present invention relates to targets and target systems, and more particularly, to an expendable radar-augmented sub-target launched from an airborne remote-controlled drone aircraft, for use in weapon training and missile testing for example.

Radio-controlled drone targets have been launched from the ground or from piloted aircraft for gun or missile testing and gun crew training, these drones being parachute-recovered and salvaged for re-use if not destroyed by weapon hits or crash landings. Also, targets have been towed from an aircraft at the end of a long tow cable while missiles are fired at the target. Both these methods 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 cable is also expensive. Further, in the case of the towed target, an angle of attack of the weapon from a head-on direction and up to a prescribed angle away from head-on is prevented due to the position occupied by the towing craft.

Thus, it is an object of the present invention to provide a new target for the function described which is workable and also economically expendable after a single use, whether intercepted or not.

Another object of this invention is to provide more than one target carried by a drone aircraft, together with means causing the fired weapon to track only the desired single target.

A further object is to provide a high speed target simulating present-day high velocity weapons, and a target which will be well away from its launching drone at missile intercept, thus avoiding the necessity of evasive launching drone maneuvers following target launch.

Briefly, our invention comprises a small, simple rocket type of target carrying radar reflection augmenting means, and support fitting members on the exterior of the target body for supporting it from a launching drone prior to ignition of the target rocket motor. The target is preferably wingless but has directional tail fins and preferably has means for spinning itself during its flight after launching. A drone type target carrier is used, with provisions for carrying at least two such targets, provisions for individually launching the targets, means for adequately masking the radar augmenting means of each target except one, and means for removing the respective masking means at a desired chosen time.

This invention will be more fully understood from the following detailed description of specific apparatus and reference to the accompanying illustrative drawings.

In the drawings:

FIG. 1 is a perspective view of a drone aircraft showing two wing-tip mounted radar-augmented sub-targets each adapted to be launched and fly for a predetermined time as a practice target.

FIG. 2 is a front view of the left half of the drone showing details of the sub-target mounting.

FIG. 3 is a side inboard profile view of the sub-target.

FIG 4 is a cross-section view of the sub-target, viewed as indicated by broken line 4—4 in FIG. 3, showing certain longitudinal reflectors therein.

FIG. 4A is a partial perspective view of the structure of FIG. 4 with the outer skin removed, showing more clearly the longitudinal reflectors.

FIG. 5 is a left side view of the front of one of the sub-targets showing a masking nose cover thereon.

FIG. 6 is a partial cross-sectional view taken as indicated by broken line 6—6 in FIG. 5, showing details of the removable nose cover.

FIG. 7 is a perspective sketch showing the top shell of the nose cover.

FIG. 8 is a perspective sketch showing the bottom shell of the nose cover.

Referring first to FIG. 1 for a detailed description of the illustrated example of the present invention, a drone aircraft 1 having a fuselage 2, wing 4, tail surfaces 5 and jet engine inlet 6 carries a sub-target 7 at each tip of the wing 4. These are sometimes called sub-targets by workers in the art because aircraft having the same or similar characteristics and size of the present drone 1 have normally been used as targets for missile and gun training. The sub-targets 7 are herein referred to as both targets and sub-targets.

As shown in FIGS. 2 and 3, each sub-target 7 carries two slippers 9 on its top side which slide in a rail 10 attached to the underside of the wing 4 and usually extending ahead of and to the rear of the wing 4. Rail 10 may be curved slightly downward or upward to match the chordwise wing contour or to launch the target 7 in a slight initial downward or upward direction. Such wing-tip mounted arrangement may of course be modified.

FIG. 3 also shows the internal arrangement of each of the targets 7. In the nose section 11 is located a radar reflector 12 such as a Luneberg lens for example, supported by lens mounting structure 14 which is preferably curved to match the rear side of the lens 12. The central section is mostly occupied by an inner body tube 15 shaped to contain a conventional fast burning rocket motor 16 having an electrical ignitor 17, and an exhaust nozzle 19. An outer skin 20 of fiberglass, for example, covers the target body to the rear of the lens 12, and a three-part metal tail is mounted at the rear. The tail surfaces 18 are preferably canted slightly as is known in the art to provide spin to the target 7 after launch. FIG. 2 shows the trailing edges 21 of the tail canted slightly to one side of the leading edges. Other spinning means can be used if desired, such as canted exhaust nozzles of the rocket motor 16.

A special unique radar reflective means is provided between the tube 15 and the outer skin 20. This comprises circumferential reflectors 24 which may be of aluminum acting also as support bulkheads, and a plastic foam filler 25 contains pairs of longitudinal strip reflectors 26 (see FIGS. 4 and 4A) mounted at right angles to each other. The reflectors 24 and 26 thus act as scintillators during target flight. This radar reflective means does not affect incident electromagnetic energy from the front of the target, but when the target is spinning and flying alone after launching, pulsed radar reflections are caused both by the circumferential and longitudinal reflectors 24 and 26, especially when the incident radiation is at an angle to the target line of flight.

As the controlled drone 1 is flying with both sub-targets 7 retained, the firing batteries on the ground, for example, can locate and track the drone 1 by means of the Luneberg lens 12. Then when the missile or weapon is fired, the ground controller of the drone 1 is notified and remotely sends a radio signal to ignite the first target motor, and the target launches itself at high

acceleration from the drone **1.** In operation, the target-tracking radar now tracks only the launched target, since the target has high acceleration (23 g for example) and since a mask, to be described next, is fitted over the nose of the unfired target to cover its Luneberg lens. The target is usually launched in a slightly upward direction, say at 13° to 17° to the horizon. Assuming an acceleration of about 23 g and a motor burning time of about 1.6 seconds, the trajectory of the target is nearly horizontal through its first 20 seconds of flight.

When the two targets **7** are carried by the single drone **1,** one of the targets has a mask **27** in the form of a non-radio-transparent cover over the target nose, as shown in FIGS. **1** and **5.** In this example let us say the left-hand target is the first to be launched, and therefore the nose **11a** of the right-hand target has the mask **27** installed.

As further shown in FIGS. **5** through **8,** the mask **27** comprises an upper half-shell **29** and a lower half-shell **30** molded and assembled in a size to be snugly slipped over the target nose and be automatically jettisoned upon command. Around the horizontal centerline of the combined shells, a first collar **31** is bonded to the lower edge of the upper half-shell **29** and a second collar **32** is bonded to the lower half-shell **30** at a position spaced parallel to the upper edge thereof. An encircling pastic foam pad **34** is provided between the edge of the lower half-shell **30** and the collars **31** and **32.** Along the midpoint of this pad **34** is intermittently laced or otherwise held a pyrofuse wire or preferably several such wires **35** which are of suitable pyrotechnic material adapted to burn rapidly when ignited. A firing squib **36** with ignition leads **37** is positioned at one end of the pyrofuse wires **35** in igniting contact therewith. Preferably, the wires are wound around the squib **36** and tied or taped thereto. The squib leads **37** come from a squib firing circuit **39** which may be in the target **7** but is preferably in the drone **1** so that it is not expended with the target **7.**

Lastly, when the half-shells are joined, a plastic film strip **40** is placed (without bonding) over the pad **34** and wires **35** on one side, and bonded on the outside only to both the adjacent collars **31** and **32** as shown in FIG. **6,** thus holding the nose cover together. The shells may be made of fiberglass and spray-coated with aluminum **41** on the inside, thus forming the mask **27** when installed over the Luneberg lens reflector **12.** The foam pad **34** is flexible and preferably somewhat resilient so that the mask **27** will easily stay on the nose during handling and flight until jettisoned.

After the first target **7** has been launched and fired upon, the drone **1** will continue being flown by the controller until the gun crew having practice is ready to fire at another target. The controller then brings the drone **1** to the desired altitude, position and heading for the second tracking procedure, in the meantime having actuated the squib firing circuit **39** by remote command radio signal, which is well known in the art. As the squib **36** is fired, the pyrofuse wires **35** burn or melt apart the plastic film strip **40,** thus separating the shells **29** and **30** and letting them blow or fall away. Now this second target is tracked, and when a missile is fired at it, the controller launches the second target to be followed and hit by the missile. After this, the drone **1** is flown back to its take-off site and recovered, to be used again by loading two more targets **7** onto the rails **10.**

A conventional type of drone tracking system is usually used to inform the drone controller on the ground. The tracking signals from the drone **1** and the remote flight control signals to the drone are indicated by the arrow **42** in FIG. **1.** If desired, smoke pulses from the drone can be employed to aid in tracking, and in fact smoke producing means can be installed in some targets **7** in the spaces where the plastic foam **25** is normally placed, if desired.

In the foregoing description, the launching of the target **7** from the drone **1** has been described as following the instant of missile firing. However, in the case where a close-range target presentation is to be made, the target **7** may be launched prior to missile firing.

The present targets **7** may of course be made in various sizes and with rocket engines of various thrusts. In an actual example, the target is less than five feet long, weighs about 33 pounds, and has a 2.75 inch rocket motor with a thrust of about 760 pounds, which achieves a maximum speed of Mach 1.4 at 10,000 feet altitude. A 7-inch Luneberg lens is provided. Thus it is seen that a very economical realistic target is provided with the speed and other characteristics as required to simulate present day weapons and to present a good target for modern missiles. The targets are abandoned after each flight, but the launching drones (also inexpensive) are flown again and again.

The same principles of the present invention would also apply if more than two sub-targets **7** were desired to be carried by the drone **1,** the additional sub-targets being carried at suitable parallel wing stations or beneath the drone body, or within the drone body. If four sub-targets are provided, three reflector masks **27** would normally be required, each having a separate and distinct jettison control system.

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 for launching from a carrier aircraft comprising:

a. a streamlined body having launching slippers protruding above the upper surface of said body;

b. a tail assembly on the aft end of said body;

c. radar reflection augmenting means in the nose of said body;

d. a rocket motor extending along the center of said body with means for igniting said motor at a chosen time to launch said target from said carrier aircraft; and

e. additional radar reflective means in said body around said motor, said additional means including a plurality of scintillators.

2. Apparatus in accordance with claim **1** wherein said motor has sufficient thrust to boost said target to supersonic speed.

3. Apparatus in accordance with claim **1** including means on said target for spinning it about its flight axis after launching.

4. Apparatus in accordance with claim **1** wherein said additional reflective means comprises lightweight

metal circumferential rings extending from said motor to the outer extent of said body.

5. Apparatus in accordance with claim 1 wherein said additional reflective means comprises lightweight metal longitudinal strips located in the annular space between said motor and the outer extent of said body.

6. Apparatus in accordance with claim 1 wherein plastic foam filler is provided in said body between said motor and the outer extent of said body, said foam filling the spaces between said scintillators.

7. Apparatus in accordance with claim 1 including removable nose cover means surrounding the front and sides of said radar reflection augmenting means and forming a radar mask, and remote control means operatively connected to said cover means to separate the latter from said target in response to actuation of said remote control means.

8. Apparatus in accordance with claim 7 wherein said nose cover means comprises two half-shells, a separable strip normally connecting said half-shells together, and pryrotechnic means ignitable by said remote control means and extending along said separable strip, said pyrotechnic means structured to burn through and separate said strip, whereby said nose cover means is jettisoned

9. Target means comprising:

a. a drone aircraft remotely controlled;

b. a streamlined powered flying target carried near each wing tip of said drone until ready to launch said target;

c. radar reflection augmenting means in each said target; and

d. a rocket motor in each said target being individually ignitable during drone flight for launching said targets individually from said drone.

10. Apparatus in accordance with claim 9 wherein each said target has additional radar reflective means therein and means for spinning said target when launched, said additional reflective means producing pulsed reflections as said target spins.

11. Apparatus in accordance with claim 9 including removable nose cover means forming a radar mask surrounding the front and sides of the radar reflection augmenting means in only one of said targets, and remote control means operatively connected to said cover means to separate the latter from said one target in response to actuation of said remote control means.

12. Target means comprising:

a. a drone aircraft remotely controlled;

b. a plurality of streamlined powered flying targets carried by said drone until ready to be launched;

c. radar reflection augmenting means in each said target;

d. drive motor in each said target being individually startable during drone flight for launching said targets individually from said drone; and

e. removable cover means forming a radar mask effectively surrounding the reflection augmenting means in each of said targets except one, and individual control means operatively connected respectively to said cover means to separate the latter from its respective target in response to actuation of its said control means.

* * * * *