LAR-12,264-1

NASA [illegible]

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(NASA-Case-LAR-12264-1) HYPERSONIC AIRBREATHING MISSILE Patent Application (NASA) 21 p HC A02/MF A01 CSCL 16D

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NASA Case No. LAR 12264-1

AWARDS ABSTRACT

HYPERSONIC AIRBREATHING MISSILE

This invention discloses a hypersonic airbreathing missle 10 using dual mode scramjet engines 20 for propulsion. The fuselage 11 is constructed of a material 54 with a high heat sink capacity and is covered with a thermal protective shield 50 and lined with an internal insulating blanket 52.

The engine-airframe integration uses the flat lower portion 13 of the lower fuselage 11 to precompress the air entering the scramjet engines 20. The precompression of air entering the scramjet inlets 22 increases as the angle angles of attack. This feature results in a highly maneuverable missile which can actually accelerate as it banks into a turn.

Another aspect of the engine-airframe integration is that the lower fuselage afterbody 26 serves as a high expansion ratio, low drag nozzle for the scramjet engines 20. This feature reduces the drag associated with a nozzle integral with the scramjet engines.

Use of a structural material 54 with a high heat sink capacity, such as Lockalloy or beryllium, results in a missle that is able to withstand the severe thermal environment of hypersonic flight. A thermal protective shield 50 is added to ensure that fuselage structure heat sink limits are not exceeded.

The novelty of the invention appears to reside in engine-airframe integration of a hypersonic airbreathing missle in combination with the use of a thermally protected heat sink structural material.

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Serial No.: 943,087
Filing Date: September 18, 1978

FOLDOUT FRAME

NASA Case No. LAR 12264-1 NELSON:nab

APPLICATION FOR LETTERS PATENT

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT James L. Hunt, Pierce L. Lawing and Don C. Marcum, Jr. citizens of the United States of America, employees of the United States Government and residents of Newport News, Virginia

APPLICATION FOR LETTERS PATENT

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BE IT KNOWN THAT James L. Hunt, Pierce L. Lawing and Don C. Marcum, Jr.

citizens of the United States of America, employees of the United States Government

and residents of Newport News, Virginia

have invented certain new and useful improvements in

HYPERSONIC AIRBREATHING MISSILE

of which the following is a specification

GPO 926-229

NASA Form 1028 Nov 63

ORIGIN OF THE INVENTION

The invention described herein was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

Present and future aerospace requirements indicate a need for an airbreathing flight vehicle capable of operating at speeds up to and including the hypersonic region, capable of long range, capable of high maneuverability, and capable of moderate acceleration. This invention relates to a hypersonic airbreathing lifting missile capable of meeting these requirements. Use of a dual mode scramjet, a jet that operates as a ramjet with subsonic combustion in the Mach 3 to Mach 5 region and operates as a scramjet with supersonic combustion at speeds above about Mach 5, provides the propulsive power in the present invention necessary to achieve the desired speed range. The engine and airframe are "integrated" in the present invention so that air entering the dual mode scramjet engines is precompressed by the flat, forward, lower portion of the fuselage, and the afterbody of the fuselage functions as a nozzle for the dual mode scramjet engines. The engine-airframe integration results in a highly efficient vehicle capable of long range, moderate acceleration, and high maneuverability. The present invention utilizes a heat sink material for construction of the fuselage with an internal insulating lining in order to withstand the extreme thermal conditions encountered at hypersonic speeds. For longer duration missions an external thermal protective shield is added and of course the size of the missile is increased.

DESCRIPTION OF THE PRIOR ART

The use of ramjets and scramjets as a means of missile or aircraft propulsion has previously been proposed. Those engines enable aircraft to achieve speeds in the hypersonic region, generally greater than Mach 4.

However, the long acceleration time and the inefficiency of these engines at low speeds tend to limit operational advantages over slower aircraft. Previous solutions to this problem have involved the use of auxiliary engines, such as turbojet engines, during acceleration and slow speed operation. This solution, however, adds weight to the aircraft and increases vehicle cost.

Many missile or aircraft types have been designed to fit the restraints of a particular mission or a particular launching system and are not adaptable to general use. Therefore, as the launch vehicle changed, or as the mission changed, it was often necessary to redesign the missile or aircraft which was not cost effective.

Prior art aircraft or missiles using scramjets or ramjets have not taken advantage of integration of the engine and airframe and have been less efficient as a result. Thus, a prior art aircraft would weigh more for a comparable range than an engine-airframe integrated aircraft and would require a heavier launch platform and heavier booster.

It is therefore an object of the present invention to provide an engine-airframe integrated hypersonic airbreathing vehicle which will weigh less for a comparable range than prior craft.

An additional object of the present invention is to provide a hypersonic airbreathing vehicle that is highly maneuverable and still capable of long range at hypersonic speeds.

A further object of the present invention is to provide a hypersonic airbreathing vehicle that is adaptable to general use and may be used for more than one type of mission.

SUMMARY OF THE INVENTION

According to the present invention, the foregoing and other objects are attained by providing a hypersonic airbreathing vehicle fabricated of a structural material with a high heat sink capacity. The hypersonic airbreathing vehicle is propelled by engine-airframe integrated dual mode scramjet engines. The exterior of the fuselage is covered with a thermal protective shield, for long range missions, and the interior of the fuselage is lined with an insulating blanket.

Severe thermal conditions will be encountered by a vehicle during hypersonic flight. To withstand these severe conditions a material with a high heat sink capacity, high conductivity, high ratio of strength to weight, and high ratio of stiffness to weight is used as fuselage structural material in the present invention. One material with the required characteristics that is used in the present invention is beryllium. Another material with the required characteristics that is used for portions of the present invention is an alloy of 38 percent aluminum and 62 percent beryllium.

To ensure that the structural temperatures do not exceed operational temperature limits of the heat sink structural material on long duration flights, the exterior of the fuselage is covered with a thermal protective shield.

The present invention uses a design concept wherein the airframe and the dual mode scramjet engines are integrated. The engine-airframe integration utilizes the flat lower portion of the fuselage forward of the dual mode scramjet engines to precompress air for the dual mode scramjet engines and the flared lower after portion of the fuselage to serve as an expansion nozzle for the dual mode scramjet engines. The engine-airframe integration results in a hypersonic airbreathing vehicle that is more efficient and more maneuverable and lighter in weight than comparable prior art vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily apparent by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a perspective of a hypersonic airbreathing vehicle according to the present invention with the dual mode scramjet engines mounted on the lower fuselage;

FIG. 2 is a sectional view of the fuselage on a leeward surface of the hypersonic airbreathing vehicle shown in FIG. 1 showing the heat sink structural material, the external thermal protective shield, and the internal insulation blanket;

FIG. 2a is an exploded sectional view of the thermal protective shield on a windward surface;

FIG. 3 is an enlarged perspective view, partially in section, of the dual mode scramjet engines which power the hypersonic airbreathing vehicle shown in FIG. 1;

FIG. 4 is an axial front-end-on perspective view of the hypersonic airbreathing vehicle shown in FIG. 1;

FIG. 5 is a side view of the hypersonic airbreathing vehicle shown in FIG. 1 with launch booster attached;

FIG. 6 is a top view of an alternate configuration of the present invention employing "armpit" mounted engines;

FIG. 7 is an axial front-end-on view of the hypersonic airbreathing vehicle shown in FIG. 6; and

FIG. 8 is a pictorial perspective showing two possible mission applications for the hypersonic airbreathing vehicle of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the drawings and specifically to FIG.1, there is illustrated a preferred embodiment of the present invention as it would be used in a hypersonic airbreathing vehicle and as designated generally by the numeral 10. As shown therein, vehicle 10 has a fuselage 11, a nose cone 12, wings 18, horizontal stabilizers 16, a vertical tail 14, and dual mode scramjet engines 20.

Referring now to FIG. 2, the fuselage 11 of vehicle 10 is basically constructed of a material 54 with a high heat sink capacity. Heat sink material 54 is covered with an external thermal protective shield 50 and lined with an internal thermal insulating blanket 52. In the preferred embodiment, heat sink material 54 used for construction of fuselage 11 is Lockalloy, a tradename for a material developed by Lockheed Aircraft, which is an alloy of 62 percent beryllium and 38 percent aluminum. Beryllium, another material with a high heat sink capacity, is used as the heat sink material 54 in wings 18, horizontal stabilizers 16, and vertical tail 14, because of potentially high heating rates. Beryllium and Lockalloy, in addition to a high heat sink capacity, both display high strength, high heat conductivity, and high stiffness. The high heat conductivity feature is desirable to prevent stress buildup due to potentially unequal heating rates. The high stiffness and structural material thickness allows the fuselage to be constructed without internal support spacers in the short range version of the missile.

The hypersonic vehicle 10 flies at a positive angle of attack, hence the upper surfaces of vehicle 10 will be on the "leeward" side of the vehicle 10. The thermal protective shield 50 on the leeward surfaces consists of alternate layers of dimpled and layers of flat titanium sheets 56, welded at the crests of the dimpled sheets to form a sandwich type structure. Pressure loads are transmitted through thermal protective shield 50 to heat sink structural material 54 with negligible deformations to thermal protective shield 50. Thermal protective shield 50 is attached to the exterior of heat sink material 54 by conventional means such as welding, fusing, bolting, etc. In the preferred embodiment thermal protective shield 50 is attached to heat sink material 54 by welding. Sections of thermal protective shield 50 are not necessarily airtight and thus, may be vented to the atmosphere.

Radiation equilibrium temperatures are more severe on the hypersonic airbreathing vehicle's 10 windward or lower surface, so a bimetal thermal protective shield 57, shown in FIG. 2a, is used on these surfaces. Bimetal thermal protective shield 57, is manufactured of titanium 56 and Inconel 58. Inconel 58 is a tradename for an alloy of 15.5 percent chromium, 1 percent cobalt, 2.5 percent titanium, 7 percent iron, 72 percent nickel, and 2 percent other metal. A mechanical interlocking of dissimilar metals, such as titanium 56 and Inconel 58, is accomplished by use of a bimetal layer 61, as shown by arrows in FIG. 2a. Bimetal layer 61 is formed by simultaneous dimpling of a sheet of each metal, Inconel 58, and titanium 56. One metal thickness is removed from each side of bimetal layer 61 at the dimpled crests 59 thereby exposing similar metals for attaching to an adjacent layer by conventional means such as welding or fusing at dimpled crests 59. Welding is used to make the attachment in the preferred embodiment. Except for the welded points at dimpled crests 59, the Inconel 58 and the titanium 56 dimpled sheets in bimetal layer 61 are not otherwise attached to each other, but are merely in contact with each other. Above bimetal layer 61 the dimpled and flat sheets are Inconel 58, and below bimetal layer 61 the dimpled and flat sheets are titanium. Use of Inconel 58 for a portion of the thermal protective shield 57 provides increased resistance to heat necessary on windward surfaces.

An insulating blanket 52 of quartz fiber material, shown in FIG. 2 is attached to the interior of heat sink material 54. Insulating blanket 52 is designed to limit heat leakage to interior components.

The dual mode scramjet engines, designated generally by reference numeral 20, are shown in FIG. 3. Air is taken into the scramjets 20 through inlets 22. An alkylated borane fuel is added at fuel injection struts 30 and burned at a combustor 28. The exhaust gases leave the scramjet engines 20 at exhaust nozzle 26. The vehicle airframe and scramjet engines 20 are integrated such that the flat lower portion 13 of fuselage 11 precompresses the air entering scramjet inlets 22. Low placement of wings 18 as shown in FIG. 4, also contributes to the precompression of air at scramjet inlets 22. As angle of attack of vehicle 10 increases, engine-airframe integration ensures that a larger portion of the air entering scramjet inlets 22 is precompressed. Thus, for modest angles of attack, the thrust in the flight path direction actually increases faster than drag. This results in high turn rate capability and means that vehicle 10 could actually accelerate in turns requiring small angles of attack.

Hypersonic vehicles require engines with exhaust nozzles with high expansion ratios of two or greater. Such nozzles, however, add a significant amount of drag to hypersonic vehicles. Another aspect of engine-airframe integration in the present invention is that the lower fuselage afterbody 26 is shaped to function as a high expansion ratio nozzle. Thus, the fuselage afterbody 26 serves as a high expansion nozzle without adding additional drag.

FIG. 4 shows an axial front-end-on view of vehicle 10 illustrating the relative positions of scramjet engines 20, wings 18, horizontal stabilizers 16, and vertical stabilizer 14. Scramjets 20 are mounted low on the "D" shaped fuselage 11 to take maximum advantage of precompression of air provided by flat lower portion of the fuselage 13. Wings 18, mounted low on fuselage 11, also contribute to precompression of air arriving at scramjet 20. An additional advantage of low, thin wings 18 is that they give a reduced radar picture. Low aspect ratio of the wing also enables wings 18 to better withstand the high stress of maneuvers. Vertical stabilizer 14 and horizontal stabilizers 16 are "all flying surfaces", that is, the whole surface pivots for control purposes rather than just a portion of the surface.

After launch, from an airplane or other launch platform, a rocket booster 40, shown in FIG. 5 is used to accelerate the vehicle 10 to the speed necessary to operate scramjet engines 20. Staging, vehicle 10 separation from rocket booster 40, would occur at about Mach 4.

FIG. 6 and FIG. 7 show, respectively, a top and front view of an alternate embodiment of a hypersonic airbreathing vehicle as generally designated by reference numeral 36. In this embodiment, scramjet engines 34 are mounted "armpit" fashion under the wings 18. This embodiment also uses a ventral fin 32.

FIG. 8 illustrates two possible missions for the hypersonic vehicles of the present invention, an air-to-air intercept, shown by flight path 43, and an air-to-surface application, shown by flight paths 47 and 48. In the air-to-air mission a target aircraft 44 is detected by a radar picket aircraft 42. Launch aircraft 41 launches the vehicle 10 (or 36) which is accelerated by booster 40. After staging, vehicle 10 accelerates to cruise speed and cruise altitude until it reaches the vicinity of target 44.

The air-to-ground scenario is roughly the same as for the air-to-air mission except the last portion of flight path 48 in the air-to-ground mission may be an unpowered glide; to extend the range of the vehicle 10 to target 46.

It is thus seen that a hypersonic airbreathing vehicle according to the present invention is highly maneuverable, capable of long ranges at hypersonic speeds, weighs less than comparable prior art vehicles, and is capable of multi-mission use. The novel engine-airframe integration pre-compresses the air entering the dual mode scramjet inlets resulting in a more efficient engine. Thus, as the hypersonic airbreathing vehicle banks into a turn and the angle of attack increases the precompression of air entering the dual mode scramjets is even greater and the vehicle can actually accelerate in a turn and is very maneuverable. The afterbody fuselage functions as a nozzle for the dual mode scramjet engines, eliminating the drag normally associated with a high expansion nozzle used for hypersonic airbreathing vehicles, again increasing the engine efficiency, reducing the weight and increasing the range and maneuverability.

The high heat sink capacity fuselage structural material is able to absorb a large amount of heat with only a small temperature rise. Thus, the present invention constructed of this material is able to function in the extreme conditions encountered at hypersonic speeds. The thermal protective shield extends the range of the hypersonic airbreathing vehicle by extending the time the vehicle can travel at hypersonic speeds without exceeding the temperature limits of the heat sink material.

The dual mode scramjet engines function efficiently at both supersonic and hypersonic speeds and allow the hypersonic airbreathing vehicle of the present invention a wide range of speeds. The use of a dual mode scramjet, rather than two different type engines for low speed and high speed, as in prior art results in lighter weight, hence greater range and maneuverability for the vehicle.

The highly efficient hypersonic airbreathing vehicle described in the present invention because of its lightweight, long range, and high maneuverability is available for use in a wide variety of aerospace and/or combat missions, and can deliver any suitable payload or warhead.

It will be understood that the foregoing description is of the preferred embodiments of the invention and is therefore merely representative. Obviously, there are many variations and modifications of the present invention in light of the above teachings that will be readily apparent to those skilled in the art. For example, while the preferred embodiment uses Lockalloy for some components and beryllium for other components, the entire hypersonic vehicle could be constructed of Lockalloy or beryllium, or other heat sink material. Also, on short range tactical missiles, the thermal protective shield would not be necessary. It is therefore understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

ABSTRACT OF THE DISCLOSURE

A hypersonic airbreathing vehicle is disclosed which uses an engine-airframe integrated dual mode scramjet engine for propulsion. The fuselage is constructed of a material with a high heat sink capacity and is covered with a thermal protective shield and lined with an internal insulating blanket. The fuselage is integrated with the dual mode scramjet engines in that the flat lower portion of the fuselage precompresses the air entering the scramjet engines, and the afterbody of the fuselage functions as a nozzle for the scramjet engines.

FOLDOUT FRAME 1

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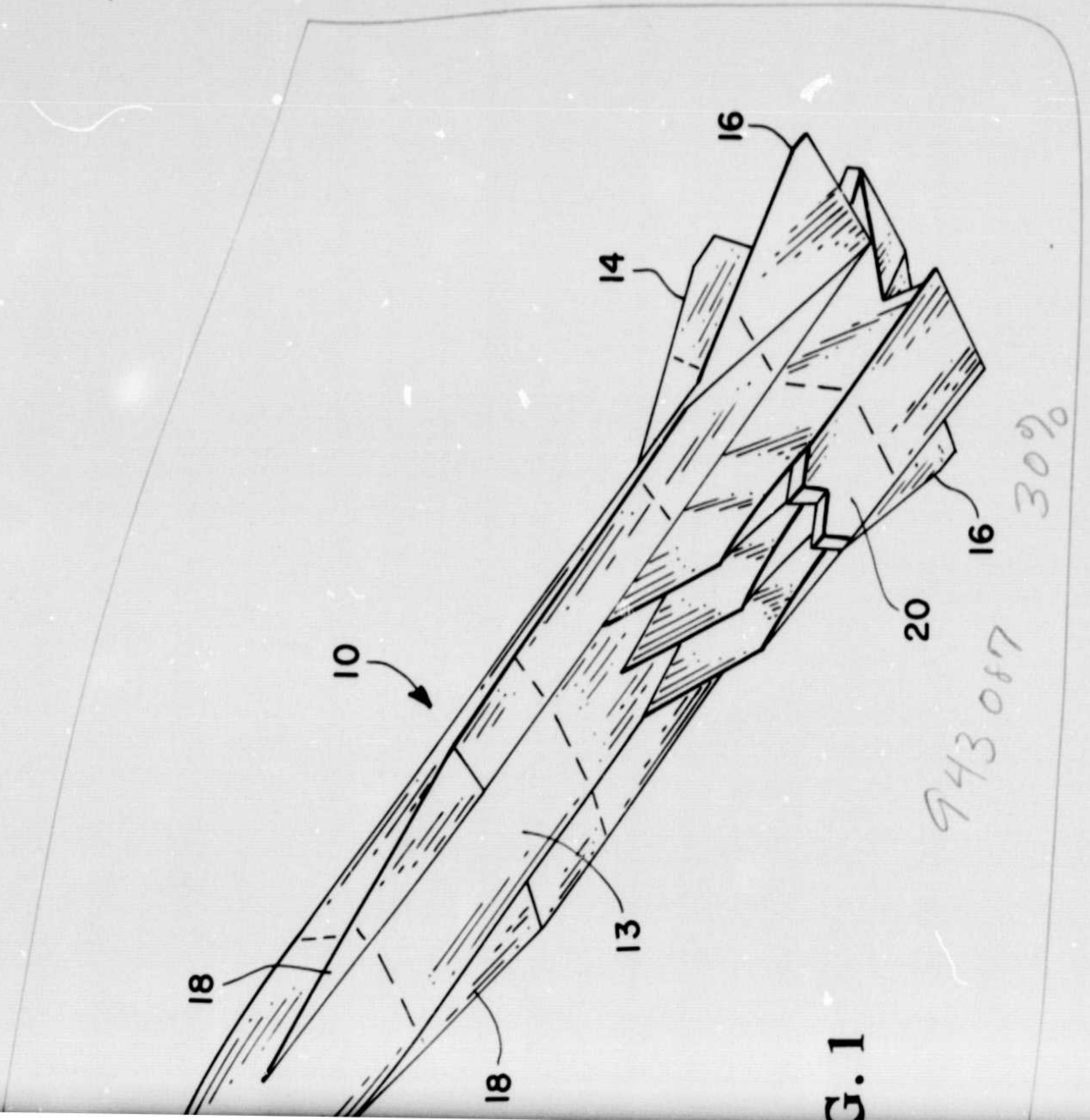
SHEET 1 OF 5
INVENTORS: JAMES L. HUNT ET AL



G. 1

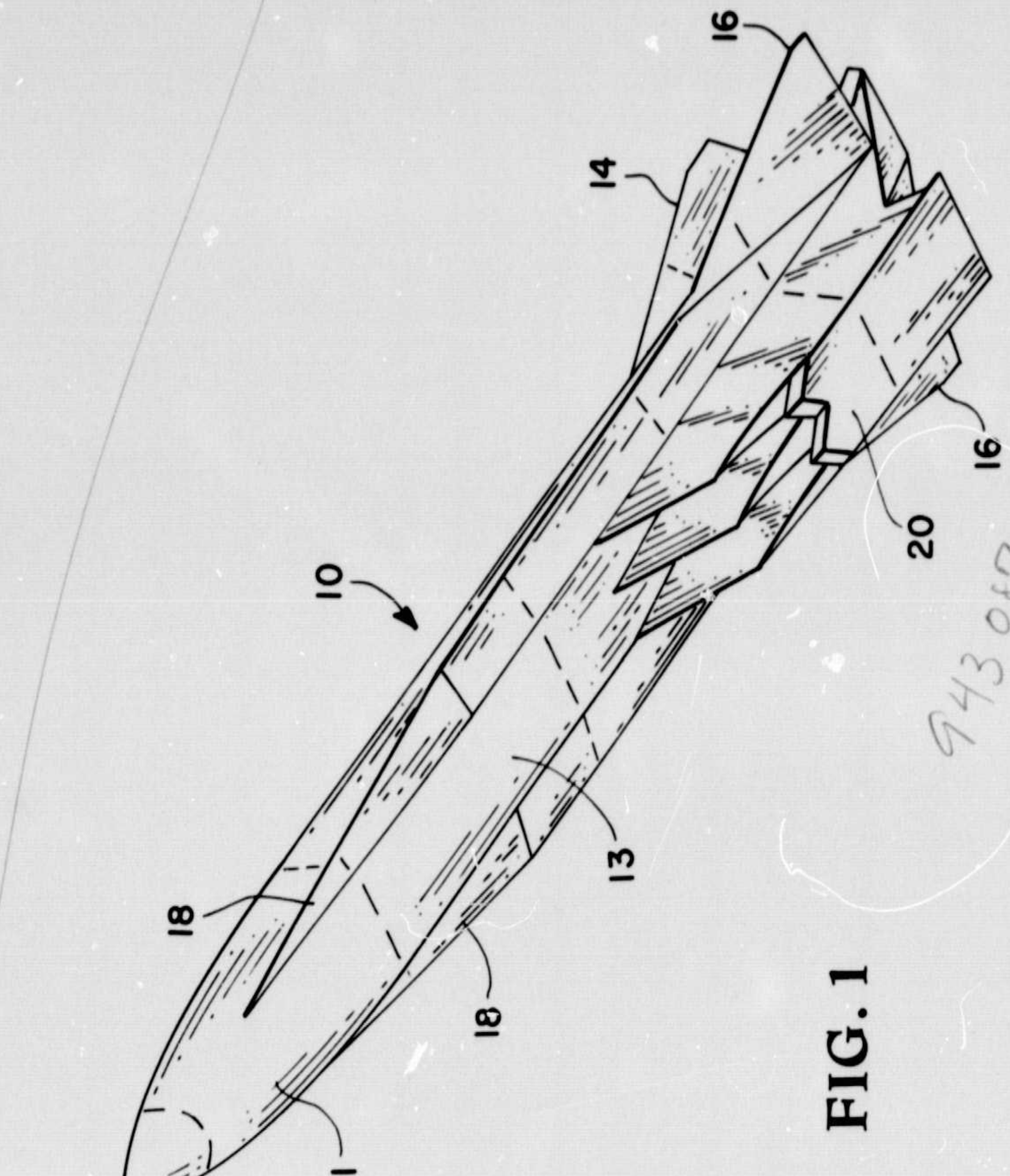


FIG. 1

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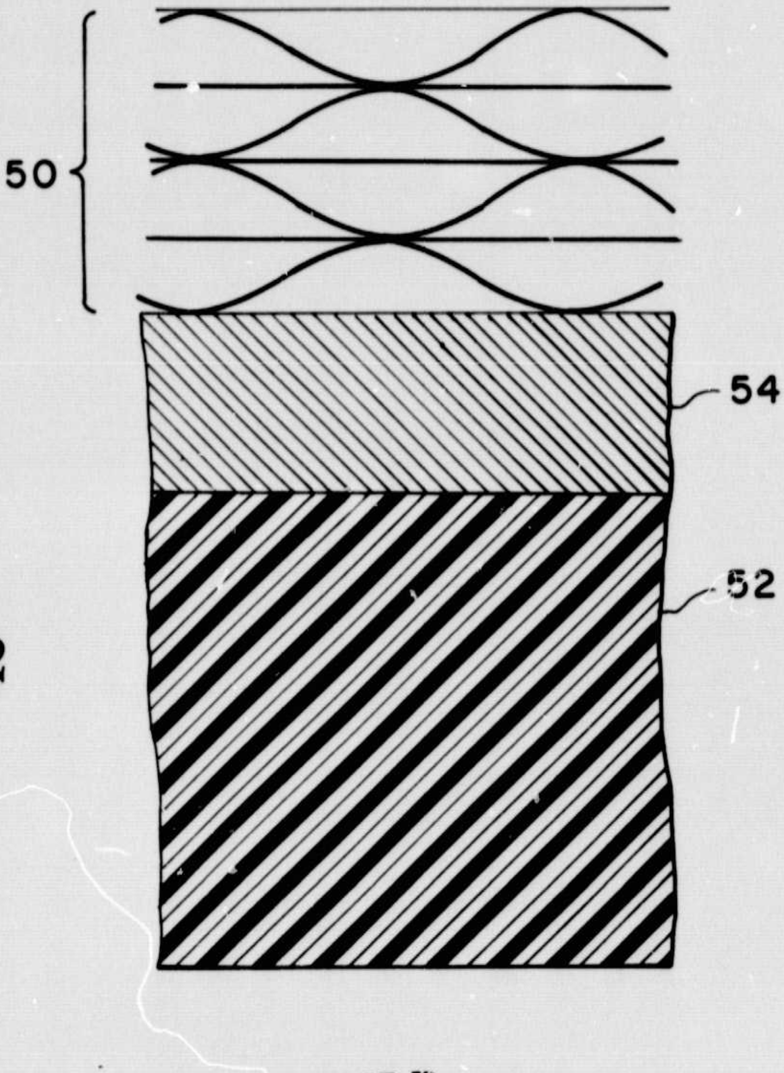

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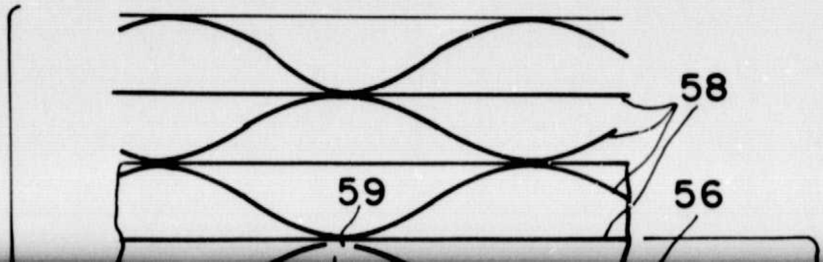

FIG. 2

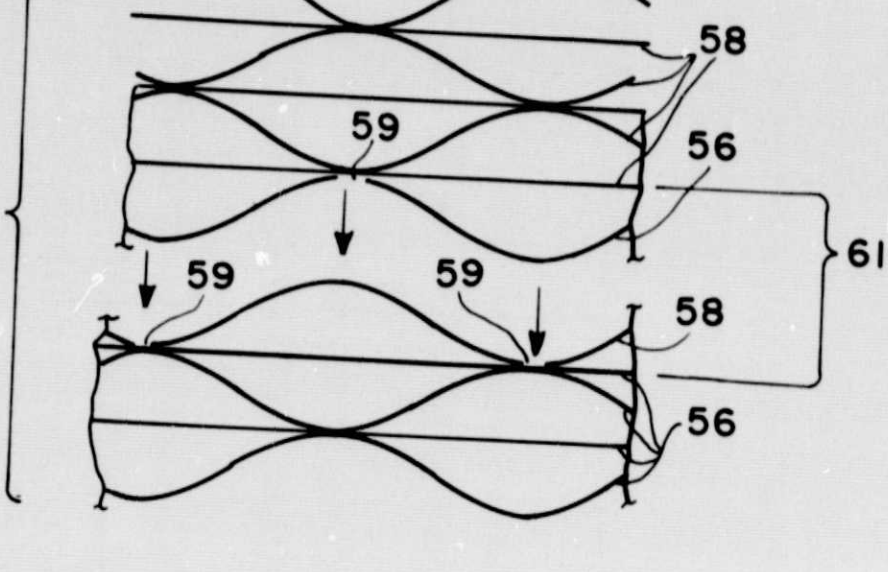

FIG. 2a

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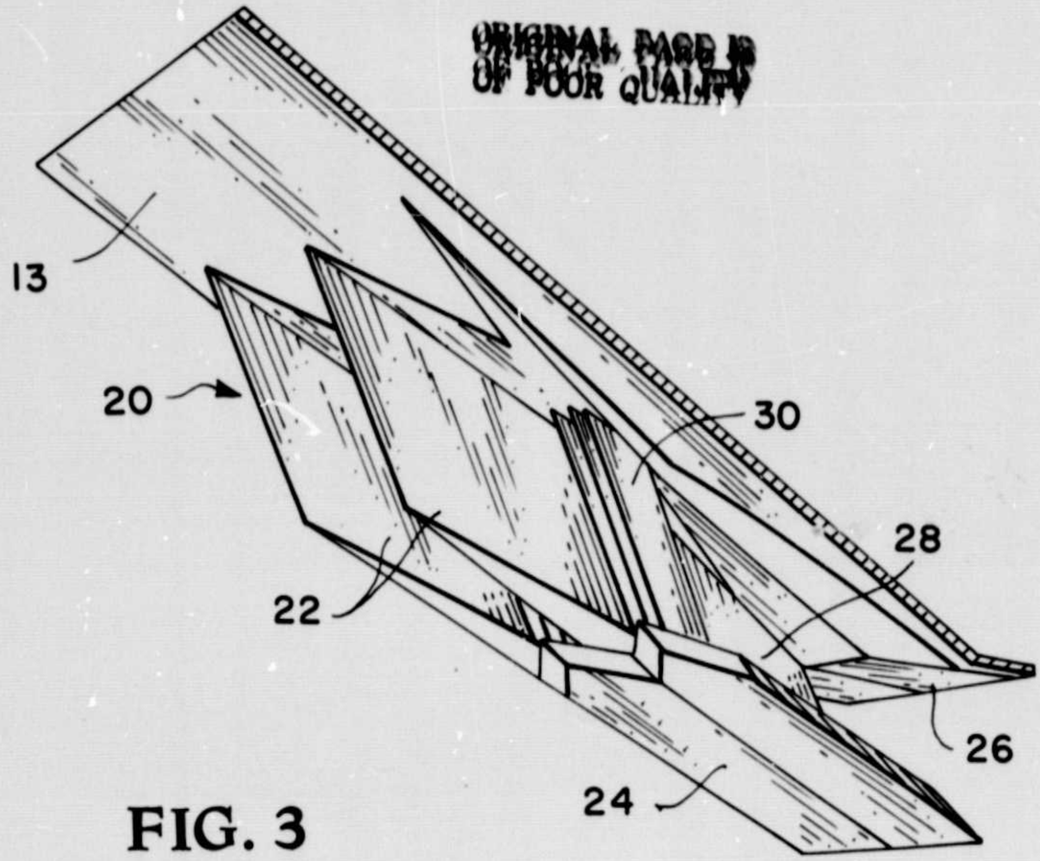

FIG. 3

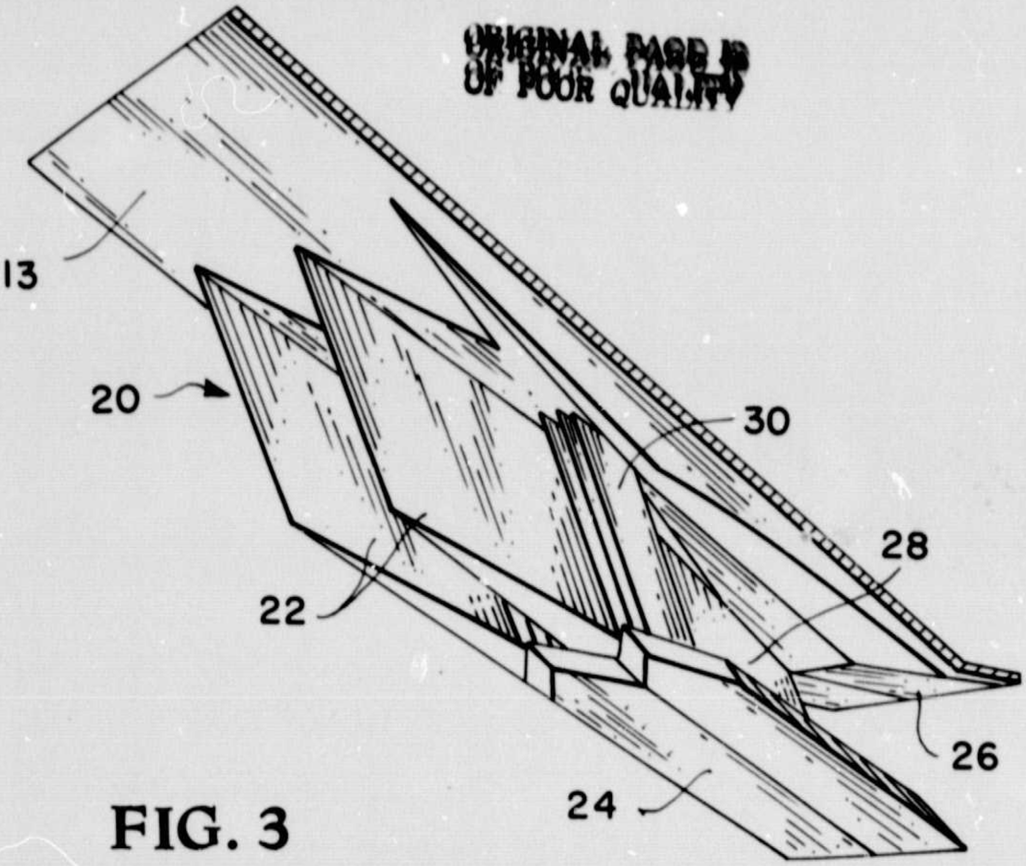

FIG. 3

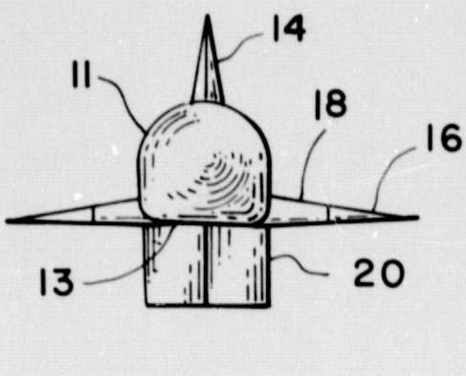

FIG. 4

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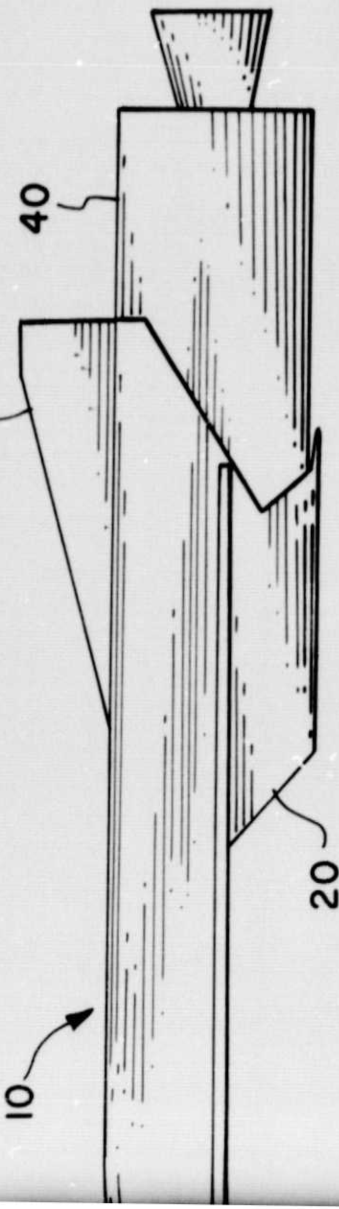

FIG. 5

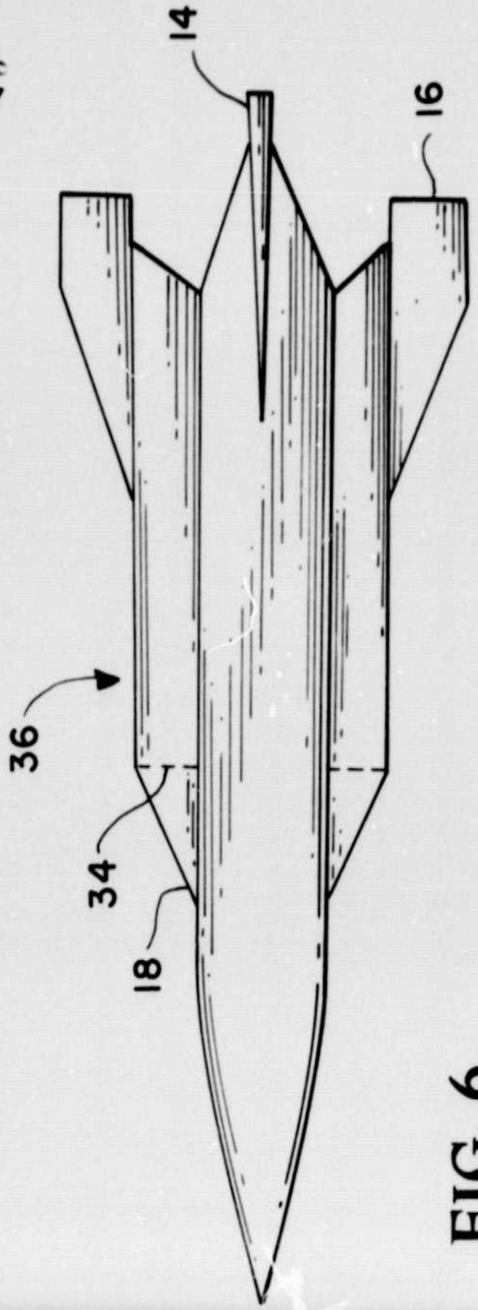

FIG. 6

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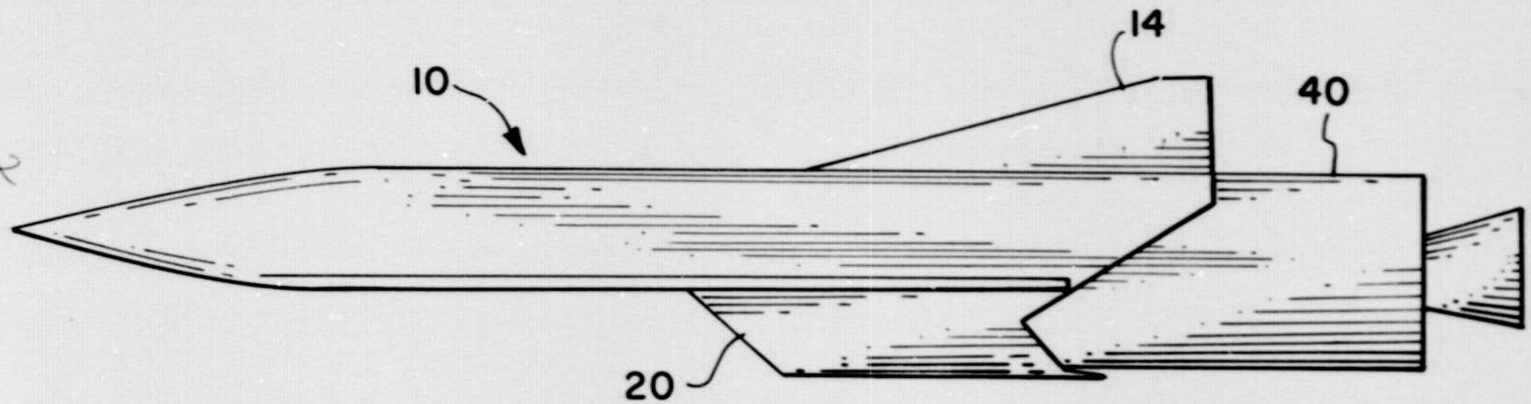

FIG. 5

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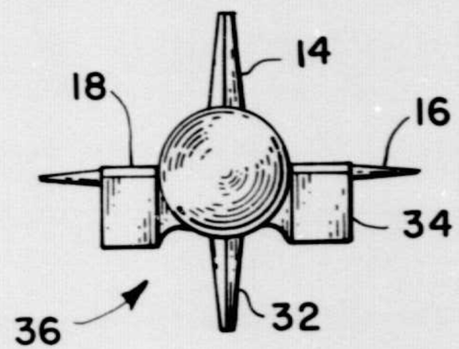

FIG. 7

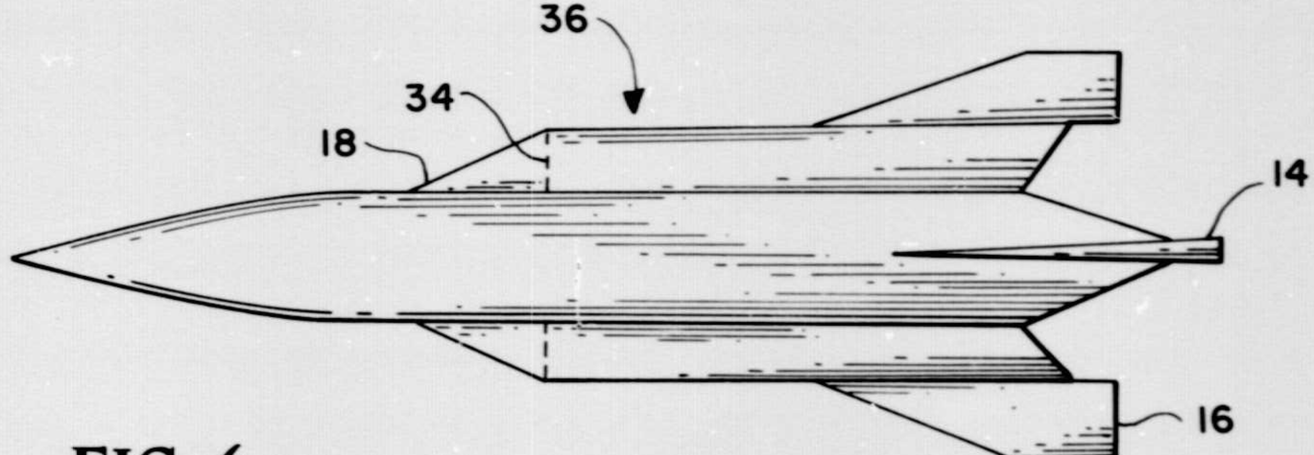

FIG. 6

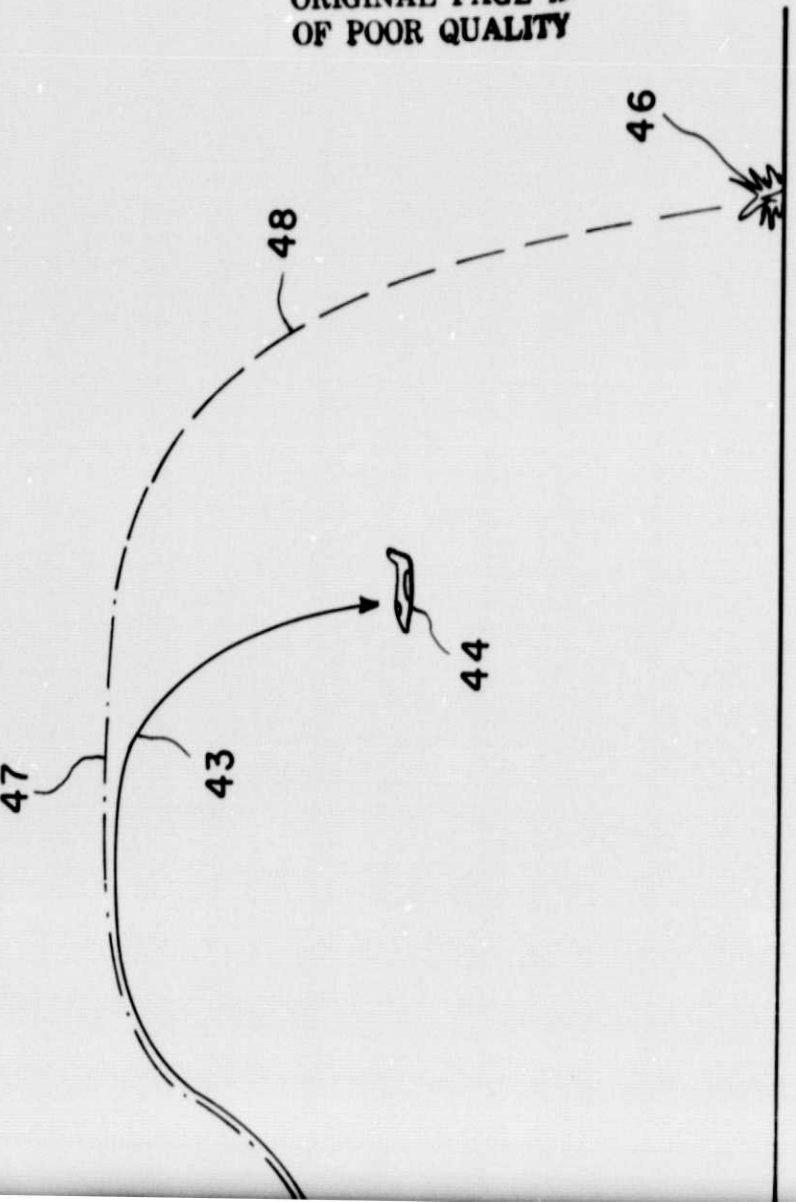

FIG. 8

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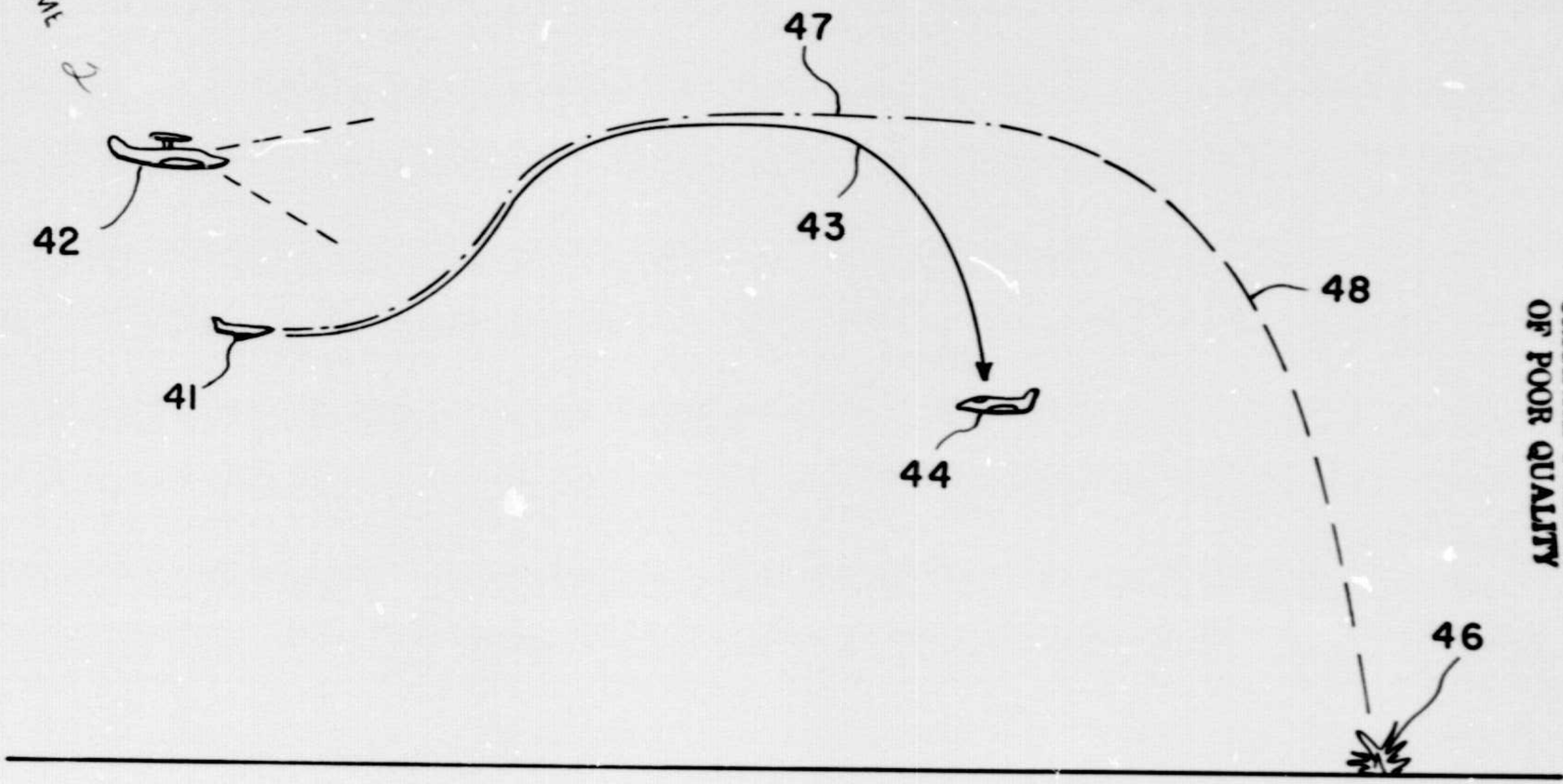

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FIG. 8