

[54] RE-ENTRY VEHICLE NOSE CONE WITH ANTENNA

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[73] Assignee: The United States of America as represented by the Secretary of the Army

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[51] Int. Cl. H01q 1/28, H01q 13/10, H01q 13/18
[58] Field of Search.....343/700, 705, 708, 711-717, 343/767-779, 872.3, 895.9, 784, 789; 102/70.2 P; 244/3.11, 3.13, 3.14, 3.19

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[57] ABSTRACT

Disclosed is a re-entry vehicle in the form of a nose cone body having an electrically conductive outer surface free of discontinuities and incorporating an antenna for exciting the body. The antenna is adjacent the vehicle base where the plasma layer during re-entry is a minimum. The antenna is disclosed as recessed into the base surface of the body.

4 Claims, 9 Drawing Figures

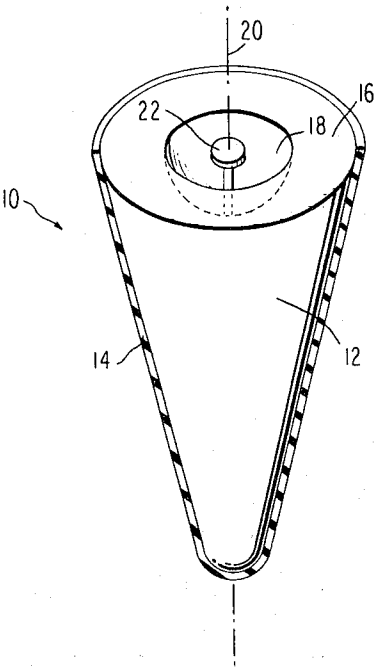


FIG. 1

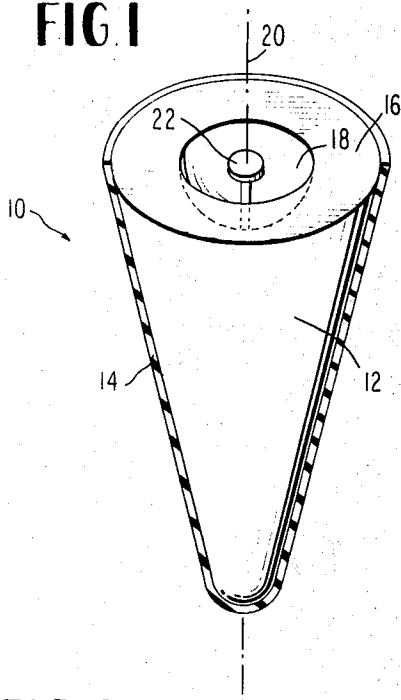


FIG. 2

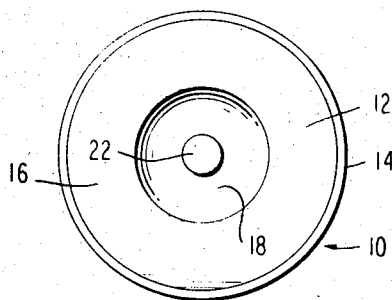


FIG. 3

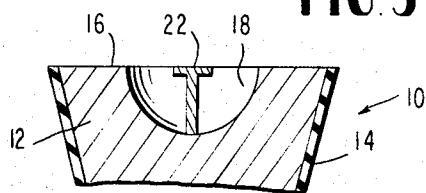


FIG. 4

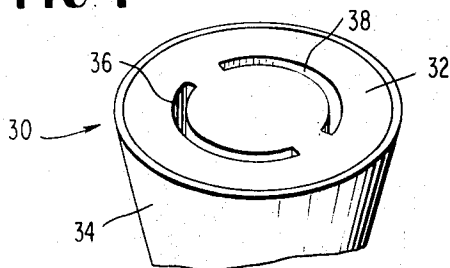


FIG. 5

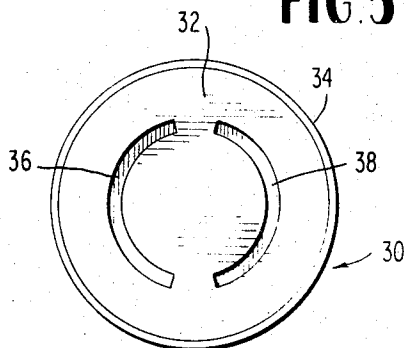
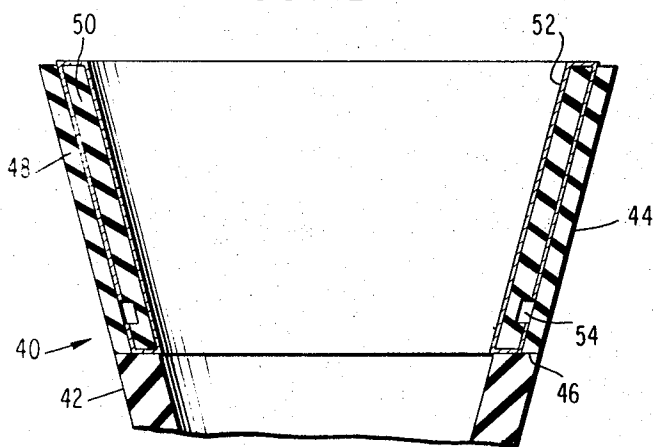


FIG. 6



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FIG. 7

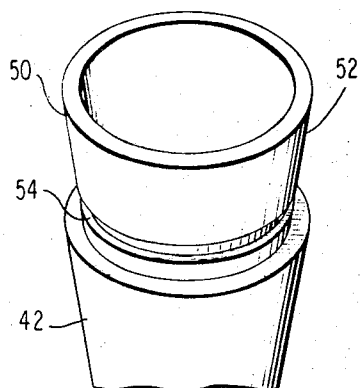


FIG. 8

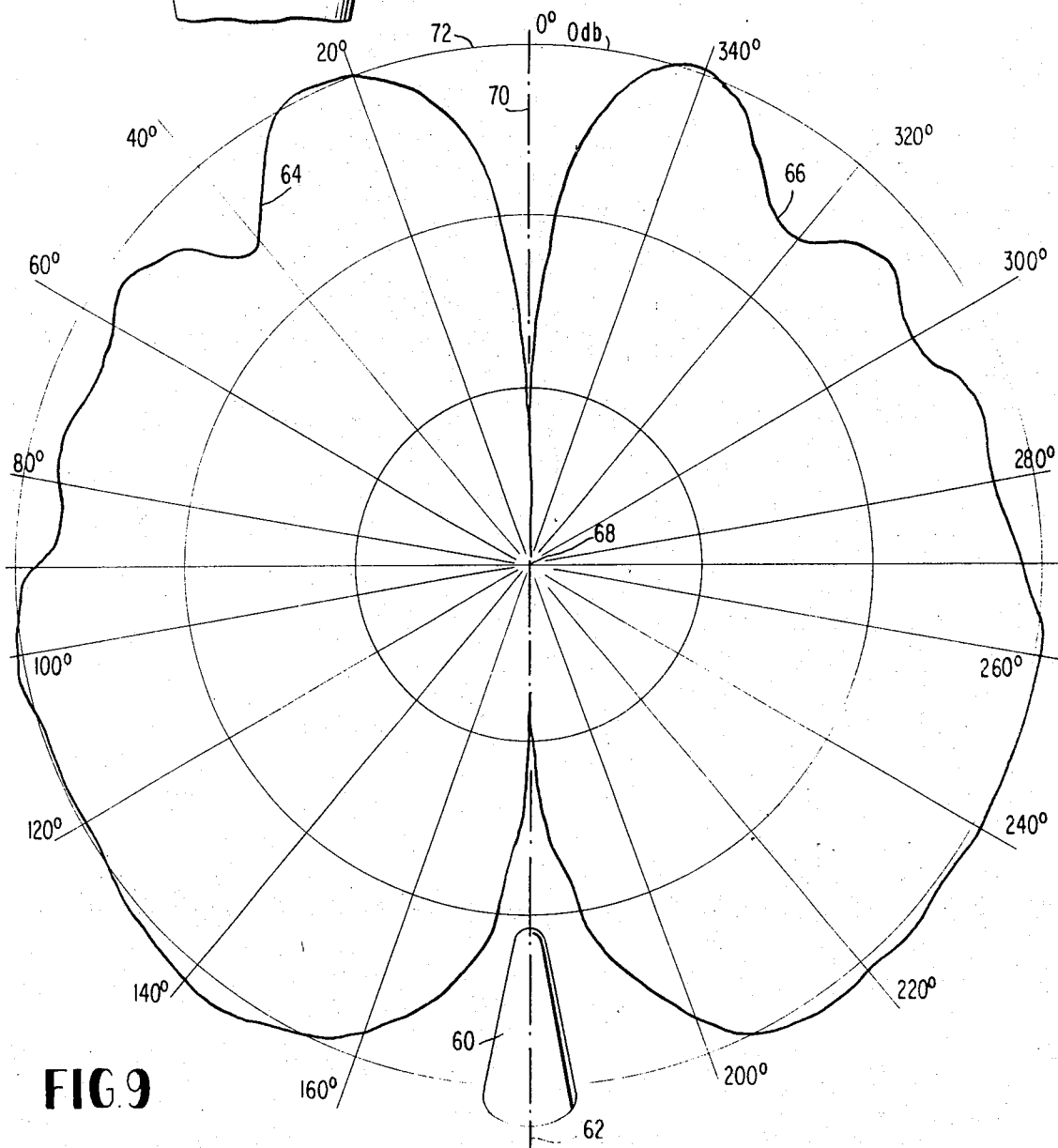
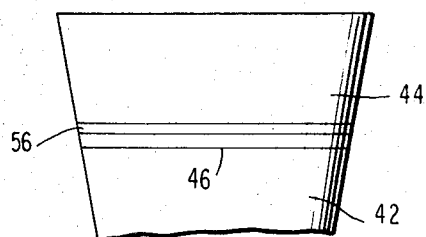


FIG. 9

RE-ENTRY VEHICLE NOSE CONE WITH ANTENNA

The invention described herein may be manufactured, used and licensed by or for the United States Government for governmental purposes without the payment to us of any royalty thereon.

This invention relates to the incorporation of various antennas into the structure of a re-entry vehicle to excite the vehicle body for radar and other applications.

Conventional constructions for exciting missile bodies generally employ stubs, monopoles, dipoles and loops as radiating elements. However, apertures for the antennas and other discontinuities constructed into the surface of the missile structures for these types of excitation elements often produce undesirable aerodynamic effects and changes in the missile's radar cross sectional area which can be extremely detrimental to the radiation pattern and to the operation of the missile system. It is therefore desirable to construct an excitation antenna for a re-entry vehicle which permits the surface of the vehicle body to be uniform and free from discontinuities. At the same time, during re-entry the plasma environment surrounding the re-entry vehicle has a serious affect on the antenna and on its radiation characteristics.

The present invention avoids the above-mentioned difficulties by providing a re-entry vehicle in which the excitation antenna is recessed within the vehicle body to provide a body surface that is uniform and free from discontinuities. In the present invention, the antenna is formed at or near the rear or base of the re-entry vehicle where the ionized layer surrounding the vehicle during re-entry is a minimum so that it has a minimum effect on the radiation characteristics of the antenna.

It is therefore one object of the present invention to provide a re-entry vehicle having improved electromagnetic radiation characteristics.

Another object of the present invention is to provide a re-entry vehicle having a body uniform and free from discontinuities and a substantially constant radar cross sectional area.

Another object of the present invention is to provide a re-entry vehicle in which the excitation antenna is recessed and located at or near the base of the vehicle.

Another object of the present invention is to provide an improved excitation antenna construction for re-entry vehicles or nose cones.

Another object of the present invention is to provide an improved re-entry vehicle in which the excitation antenna for the vehicle is incorporated in the re-entry vehicle radome wall.

These and further objects and advantages of the invention will be more apparent upon reference to the following specification, claims, and appended drawings, wherein:

FIG. 1 is a perspective view of a re-entry vehicle or nose cone constructed in accordance with the present invention with the radome shown in cross section for the purposes of explanation;

FIG. 2 is a rear view of the re-entry vehicle of FIG. 1;

FIG. 3 is a partial cross section through the base of the re-entry vehicle of FIG. 1 showing the hemispherical shape of the recess in the vehicle base;

FIG. 4 is a partial perspective view of the re-entry vehicle similar to that of FIG. 1 incorporating a modified excitation antenna in the form of a pair of recessed waveguide cavities;

FIG. 5 is a rear view of the re-entry vehicle of FIG. 4;

FIG. 6 is a partial cross section through a re-entry vehicle radome showing a modified excitation antenna for a re-entry vehicle;

FIG. 7 is a perspective view of the radome of FIG. 6 with the outer section of the upper end of the radome removed for clarity;

FIG. 8 is an elevational view of a radome constructed in accordance with FIGS. 6 and 7 but incorporating a transparent microwave window in the outer section of the radome base; and

FIG. 9 shows a typical radiation pattern for a re-entry vehicle constructed in accordance with this invention.

Referring to the drawings, FIGS. 1-3 show a re-entry vehicle, generally indicated at 10, in the form of a more or less conventional nose cone or vehicle body 12 having an electrically conductive metallic outer skin and surrounded by or enclosed by a relatively thin layer of dielectric 14 forming a heat shield or radome for the vehicle. The radome is preferably formed of quartz or other suitable insulating material.

The surface base 16 forms the base of body portion 12 and is formed with a central hemispherical recess or cavity 18 aligned with the longitudinal axis 20 of the re-entry vehicle 10. Extending upwardly from the bottom of recess 18 along axis 20 is an antenna 22, preferably in the form of a top-loaded folded monopole. Monopole 22 is constructed so that it does not extend beyond the plane of the base 16 of the vehicle body so that it does not project from the body where it may be adversely effected by the plasma layer surrounding the body during re-entry and even wholly or partially burned off by the excessive heat to which the body may be subjected during re-entry.

FIGS. 4 and 5 show a modified re-entry vehicle construction, generally indicated at 30, again comprising a body having a base 32 and surrounded by a radome insulating layer 34. The re-entry vehicle 30 is similar to that shown in FIGS. 1-3 with the exception that the base 32 has formed in it a pair of arcuate recesses or cavities 36 and 38 forming a pair of waveguide cavities. Each of the cavities 36 and 38 is slightly spaced radially inward from the outer edge of the base of the vehicle body and extends approximately 150° about the vehicle axis. It is desirable to use as much of the surface area available commensurate with the operating frequency of the antenna formed by the waveguides 36 and 38 and each cavity may extend as much as about 170° about the axis. The cavities may be excited in any conventional manner, such as by a center probe or loop and are preferably excited in phase from a common source.

FIGS. 6-8 show a further antenna modification for exciting the body of a re-entry vehicle. In this embodiment, the antenna is formed in the radome surrounding the vehicle body and for the sake of clarity, the body itself which the radome surrounds has been omitted from FIGS. 6-8. Referring to those FIGURES, a radome, generally indicated at 40, adapted to surround a re-entry vehicle body, such as the body 12 of FIG. 1, is provided with a lower section or nose section 42 and an upper or base section, generally indicated at 44. The two sections of the radome, which typically may be formed of suitable insulating material such as quartz from about one-half to about 1 inch thick, may simply be formed by slicing off the base of a conventional radome along a horizontal plane as indicated by the separation line at 46.

Base section 44 of the radome 40 is cut longitudinally to form two concentric sections comprising outer section 48 and inner section 50. Inner section 50 is provided with a conductive metal coating, such as copper plating as indicated at 52, over its entire surface to form a dielectric loaded annular or ring antenna. After the inner section 50 has been copper plated or similarly coated with a layer of electrically conductive material, an annular ring 54 is cut into its outer surface about halfway through inner section 50. This ring forms a radiating slot for the dielectrically loaded annular antenna and after the ring has been cut into the radial center section 50, it is then slipped back inside outer section 48 and the two sections suitably joined together and to the lower section 42 of the radome. The radome may then be placed over and secured to a vehicle body, such as the body 12 of FIG. 1. However, in this embodiment, the excitation antenna is formed in the radome and no antenna, such as the monopole 22, is required on the vehicle body itself. In the event the radome 40 is made from a material other than quartz, then the outer section 48 of the radome may be provided with an annular quartz window 56, as illustrated in FIG. 8, through which energy from the annular antenna may radiate outwardly of the radome, i.e., the quartz window 56 should be in radial alignment with the radiating slot 54 of the antenna.

It is apparent from the above that the present invention provides an improved construction and arrangement for incorporating an excitation antenna in a re-entry vehicle subject to the severe heat and plasma environments which such a vehicle undergoes during re-entry into the earth's atmosphere. Important features of the invention include recessing the antenna into the body of the vehicle or incorporating it in the radome so as to preserve the smooth and unobstructed surface which the vehicle must have to avoid undesirable aerodynamical effects. In addition, the vehicle excitation antenna is located at or near the base of the vehicle body or radome where it has been found that the ionized layer surrounding the re-entry vehicle during re-entry into the atmosphere has a minimal affect on the antenna radiation characteristics.

The various antenna constructions may be excited in a conventional manner, i.e., the monopole of the embodiment of FIGS. 1-3 may be excited in the conventional manner, the cavities 36 and 38 in the embodiment of FIGS. 4 and 5 may be excited by a center probe or loop, preferably in phase from a common source and the radome antenna illustrated in FIGS. 6-8 may be excited with a post extending across the cavity. The antenna constructions illustrated excite currents on the skin of the vehicle body which flow along the skin surface to produce a substantially constant radar cross sectional area for the missile. A typical radiation pattern for an antenna constructed in accordance with the present invention is illustrated in FIG. 9 where a nose cone, generally indicated at 60, is shown along a longitudinal axis 62 to provide a symmetrical radiation pattern having a substantially symmetrical pair of lobes 64 and 66. The radiation pattern is plotted from the central point 68 with the relative power indicated along the vertical axis 70. The zero db level is illustrated by the circle 72.

It should be understood that the invention is not limited to the exact details of construction shown and described herein for obvious modifications will occur to persons skilled in the art.

What is claimed and desired to be secured by United States Letters Patent is:

1. A re-entry vehicle comprising a body portion having an outer surface substantially free of surface discontinuities which terminates in a base surface having the shape of a slice of cross-sectional area of said body portion, said base surface including a hemispherical recess and said antenna comprising a top-loaded monopole antenna mounted in said recess.

2. A re-entry vehicle comprising a body portion having an outer surface substantially free of surface discontinuities which terminates in a base surface having the shape of a slice of cross-sectional area of said body portion, an antenna for exciting said body portion recessed in said base surface, said antenna comprising a pair of radiative, resonant, wave guide cavities extending in one direction in the longitudinal axial direction of said body portion and extending in the other direction arcuately about the longitudinal axis of said body portion.

3. A re-entry vehicle comprising a body portion having an outer surface substantially free of surface discontinuities which terminates in a base surface having the shape of a slice of cross-sectional area of said body portion, a protective radome comprising part of said body portion, an antenna for exciting said body portion being recessed in said base surface and being mounted on said radome and wholly contained beneath the surface of said radome, said antenna comprising a conductive ring having a radially inner side on the inner wall of said radome and a radially outer side embedded in said radome, and including an annular slot in its radially outer side for radiating electromagnetic energy outwardly through a portion of said radome.

4. A re-entry vehicle according to claim 3 including an annular window in said radome surrounding said slot and transparent to microwave energy.

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